ASSESSMENT OF PULMONARY FUNCTION TEST IN CHRONIC SMOKERS

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CERTIFICATE

This is to certify that this dissertation entitled ***"ASSESSMENT OF PULMONARY FUNCTION TEST IN CHRONIC SMOKER"*** submitted by ***DR. T. MUTHUVEL*** to the faculty of Medicine, The Tamil Nadu Dr. M.G.R. Medical University, Chennai is in partial fulfillment of the requirement for the award of MD Degree Branch I (General Medicine) is a bonafide research work carried out by him under our direct supervision and guidance.

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INTRODUCTION

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Use of tobacco products, including cigarettes, cigars, pipes and snuff is associated with high mortality and morbidity. Cigarette smoking is now responsible for more than one million premature deaths each year. Main stream cigarette smoke inhaled by the smoker is composed of a particular phase and a gas phase; tar is the total particulate phase without water or nicotine. There are 0.3 to 3.3 billion particles per milliliter of mainstream smoke and more than 4000 constituents, including 43 known carcinogens. In addition to these chemical carcinogens, cigarette smoke contains carcinogenic metals such as arsenic, nickel, cadmium and chromium; potential promoters such as acetaldehyde and phenol; irritants such as nitrogen dioxide and formaldehyde; cilia toxins such as hydrogen cyanide and carbon monoxide.

Carbon monoxide is a colorless, odorless gas produced during incomplete combustion of tobacco. It has 200 times higher affinity for hemoglobin than oxygen does and impairs release of oxygen from hemoglobin. Thus carbon monoxide exposure decreases the delivery of oxygen to peripheral tissues. Carbon monoxide also binds to other hemi containing proteins, such as myoglobin and cytochrome oxidase.

Nicotine is an important constituent of cigarette smoke. It is an alkaloid that readily crosses the blood brain barrier and stimulates nicotine receptors in the brain. It is also responsible for the acute pharmacologic effects associated with tobacco use that are most likely mediated by

catecholamines; increased heart rate increased contractility and cardiac output and mobilization of free fatty acids. Nicotine is responsible for tobacco addiction.

Unburned cured tobacco contains nicotine, carcinogens and other toxins capable of causing gum disease and oral cancer.

Cigarette smokers are increased risk of developing cardio vascular disease like large vessel atherosclerosis and coronary artery disease, myocardial ischemia, myocardial infarction, sudden death, systemic hypertension, cerebrovascular disease and stroke, subarachnoid haemorrhage.

Peripheral vascular disease like thromboangitis obliterans (TAO) and arteriosclerosis obliterans are common in smoker.

Gastric and duodenal ulcer disease is more prevalent in smokers. Smoking impairs ulcer healing, favors recurrence of ulcers, inhibits pancreatic HCO_3 secretion and decreases the pressure of esophageal and pyloric sphincter.

Various types of cancer are caused by chronic smoking. They are cancer of oral cavity, larynx, lung, esophagus, stomach, pancreas, kidney, urinary bladder, uterine cervix, myelocytic leukemia.

Male smokers have 4-25 times higher mortality secondary to COPD than non smoker. Prolonged cigarette smoking impairs ciliary function; inhibit function of alveolar macrophages and lead to hypertrophy and hyperplasia of mucus secreting glands. It increases airway resistance due to vagal nerve mediated smooth muscle constriction by way of stimulating submucosal irritant receptors**.**

Primary care physicians are in a unique position to monitor the respiratory health of the community. The inclusion of Spirometry as a routine test, especially in patients at risk of respiratory disease (e.g. Smokers), will lead to earlier detection of respiratory disease and more effective intervention and treatment.

Ninety percent of non-asthmatic patients with airflow obstruction have COPD. In addition, COPD is characterized by an accelerated decline in spirometric values. The disease progresses slowly and the early signs (e.g. Cough and sputum) are often ignored or are not significant enough to prompt the patient to seek treatment. Consequently, a diagnosis is often not made until about half of the lung's large reserve capacity is already lost causing significant symptoms. Because there is a close relationship between the risk of COPD and the intensity and duration of smoking, Spirometry is a very important test for the early detection of COPD in smokers and ex-smokers. When provided with evidence of airflow limitation, patients are more likely to cease smoking and this will reduce the rate of FEV_1 decline and thus modifies the natural history of the disease.

Although there is the possibility that a finding of normal Spirometry in a smoker may reinforce their smoking habit, such findings can be used as 'teachable moments' when the patient has increased awareness of the risks.

Abnormalities in pulmonary function test are common in smokers. Spirometric analysis shows a restrictive or obstructive pattern in chronic smokers.

Restrictive pattern is characterized by reduced total lung capacity and reduced vital capacity. Obstructive pattern is characterized by decreased FEV_1/FVC ratio. Reduced mid expiratory flow rate ($FEF_{25-75\%}$) detects only small airway involvement.

Spirometry screening of smokers and ex-smokers has been shown to enhance early detection of COPD when treatment and intervention can have a positive effect on disease progression. Furthermore, the demonstration of airflow limitation to the patient has been shown to motivate smokers to quit.

In this study, 150 chronic smokers and 50 non smokers who came to hospital for respiratory or non respiratory symptoms are evaluated for lung function test by spirometry and categorized according to GOLD criteria.

AIM OF THE STUDY

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★ ***Aim of the study is to find out prevalence of undetected pulmonary function abnormalities in chronic male smokers.***

REVIEW OF LITERATURE

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Smoking

Cigarette smoke is a heterogeneous aerosol produced by incomplete combustion of tobacco leaf. On an average, smokers lose more than one day of life every week.

Main stream smoke:

Smoke emerging from mouthpiece during puffing

Side stream smoke:

Smoke emitted between puffs at the burning cone and from the mouthpiece. Side stream smoke contains more of particulate matter especially carcinogens.

Contents of Cigarette Smoke

Carcinogens

- ☞ Tar
- ☞ Polynuclear aromatic hydrocarbons
- ☞ Naphthylamine
- ☞ N – nitrosonornicotine
- ☞ Benzopyrene
- ☞ Trace metals – nickel, arsenic.
- ☞ Polonium 210
- ☞ Nitrosamines, hydrazine, vinyl chloride

Co-carcinogens

- ☞ Phenol, cresol, catechol .

Tumor accelerator

Indole, Carbazole

Pharmacology of Cigarette Smoke

There are more than 4000 substances identified in cigarette smoke. They have antigenic, cytotoxic, mutagenic and carcinogenic properties.

Nicotine is a toxic alkaloid present in cigarette smoke, which is both a ganglionic stimulant and a depressant.

Acute cardiovascular effects of nicotine[1]

Are increased in,

a. both systolic and diastolic BP
b. heart rate
c. force of myocardial contraction and excitability
d. myocardial oxygen consumption
e. coronary artery blood flow
f. Peripheral vasoconstriction.

Major carcinogens found in cigarette smoke are polynuclear aromatic hydrocarbons, aromatic amines and nitrosamines. Co-carcinogens like catechols enhance the carcinogenicity.

Carbon monoxide is a toxic gas found in smoke (2-6%) and causes polycythemia and CNS impairment. This is the major cause for COPD.

Smoking also causes chronic cough, sputum, dyspnoea, change in lung function tests, increase in incidence of pneumonia and inflammatory lung disease.

Characteristics of Smokers

Smokers drink more alcohol, coffee and tea than non smokers, Menopause comes earlier in smoking women. Smokers have impaired exercise performance, impaired immune system compared to nonsmokers. They show increase in hematocrit, WBC count and platelet count, there is decrease in leucocyte vitamin C levels, serum uric acid and albumin in smokers. The ratio of HDL to LDL cholesterol is also reduced.

Clinical Correlations

Common disorders associated with smoking include atherosclerotic cardiovascular disease, cancer and COPD. The risk is dependent on duration, intensity and type of smoke exposure.

Smoking and Cardiovascular Disease

Smoking, hypertension, and hypercholesterolemia are three major risk factors for coronary heart disease (CHD). Presence of two out of the three risk factors may produce a 4 fold increase in CHD risk and 3 risk factors produces a 8 fold increase in CHD risk.

- ★ CHD death rates are 60-70% greater in male smokers than in nonsmokers.
- ★ Sudden death is 2-4 times more common in young male smokers.
- ★ Women smokers also develop CHD especially when they take oral contraceptive pill also.

Those who continue to smoke after acute MI are most likely to die from CHD than those who quit smoking. Smokers have increased perioperative mortality than nonsmokers.

Similarly, cerebrovascular disease and stroke is also common in smokers. In women smokers, subarachnoid haemorrhage is more common; oral contraceptives increase the risk in them.

Peripheral vascular disease like Thromboangitis obliterans (TAO) and arteriosclerosis obliterans are common in smokers.

Hypertensives who smoke are at a greater risk of developing malignant hypertension and they die from complications of hypertension.

Smoking and Cancer[2]

Smoking causes cancer of	
Oral cavity	Pancreas
Larynx	Kidney
Lung	Urinary bladder
Esophagus	Uterine cervix
Stomach	Myelocytic leukemia

Smoking Index (SI)

- ★ SI = number of cigarette/day x total duration in years.
- ★ SI <100 Mild smoker
- ★ SI 101 - 300 Moderate smoker
- ★ SI > 300 Heavy smoker

Lung cancer is common if smoking index is more than 300.

Pack Year

Number of pack years = number of packet of cigarette/day x number of years (one pack = 20 cigarettes.) The risk of developing lung cancer is 40 times more in patients who smoke 2 packs per day for 20 years.

Smoking and Respiratory Disease

Male smokers have 4-25 times higher mortality secondary to COPD than nonsmokers.

Prolonged cigarette smoking impairs ciliary movement, inhabits function of alveolar macrophages and leads to hypertrophy and hyperplasia of mucus secreting glands[3]. It also inhibits antiproteases and causes polymorphs to release proteolytic enzymes acutely. The inhaled cigarette smoke increase airway resistance due to vagally mediated smooth muscle constriction by way of stimulating submucosal irritant receptors.

Abnormalities in pulmonary function tests, (measurements of elastic recoil, airflow in large and small airways and diffusing capacity) are common

in smokers[4]. There is increase in incidence of respiratory infections and deaths due to pneumonia and influenza. Postoperative respiratory complications, spontaneous pneumothorax are also common. Chronic pharyngitis, chronic laryngitis and chronic bronchitis occur more frequently in smokers.

Patients with airflow obstruction are at increased risk of developing post surgery complication such as pneumonia and atelectasis. Therefore, Spirometry is indicated in pre surgical check up before thoracic and upper abdominal surgery and in patients with history of smoking, cough, wheezing or pulmonary disease. Presence of mid obstruction carries a low risk but moderate to severe airway obstruction puts a patient in high risk category[5].

22% of adult male population of India is smokers. Ideally all smokers above the age of 40 should get Spirometry done for early detection of emphysema in asymptomatic smokers[6].

Smoking and Gastrointestinal Disorders[7]

In smokers, there are changes in hard and soft tissues of the mouth, discoloration of the teeth and there is decreased sensation of taste and smell.

Gastric and duodenal ulcer disease is more prevalent in smokers both in males and females. Smoking impairs ulcer healing, favors recurrence of ulcers, inhibits pancreatic HCO_3^- secretion and decreases the pressure of esophageal and pyloric sphincters. Inhibition of nocturnal acid secretion by H_2 blockers is also prevented by smoking.

Smoking and Depression[8]

Prevalence of smoking is increased in those who have a major depressive disorder.

Smoking and Body Weight

There is an inverse association between smoking and body weight. Weight gain occurs after cessation of smoking.

Smoking and Pregnancy

Smoking delays conception and smoking during pregnancy affects the fetus. Babies born to mothers who smoke have a weight of about 170 gm less than the babies born to non-smokers. This is due to impaired uteroplacental circulation.

Spontaneous abortion, fetal death, neonatal death and sudden infant death syndromes are also common. The long term physical growth and intellectual development of the child is also affected.

Passive Smoking

Since side stream smoke is diluted in a large volume of air, smoke exposure from involuntary inhalation is less than that associated with smoking.

Majority of housewives in rural areas of our country use smoky fuels for cooking such as firewood, dried dung, crop residues and agricultural wastes. A housewife spends around 6 hours a day in such an environment[9]

exposure to such pollution leads to restrictive and obstructive respiratory disease[10].

Vehicular pollution has been found to be an important cause of respiratory symptoms in people in metropolitan cities[11].

Passive smoking is one of the causes for lung cancer in nonsmokers. Parental smoking is a cause for middle ear effusions, acute or chronic respiratory illness and asthma in children. Passive smoking may also cause coronary heart disease.

Smoking and Drugs

Tobacco smoke constituents induce hepatic microsomal enzyme systems which are important in the metabolism of drugs like propranolol, theophylline and propoxyphene and hence increase in dose in smokers is recommended.

Type of Smoking

Using low tar-nicotine cigarettes shows decrease in risk of developing lung and laryngeal cancers. The risk is the same for both high tar-nicotine cigarettes and low tar-nicotine cigarettes when the number of cigarettes smoked per day and the duration of smoking are more in the latter group.

Using pipe or cigar reduces the overall risk. (the patients do not inhale more smoke since the alkaline pH of tobacco used in them is a potent irritant of respiratory tract.)

Death rates of cigar, pipe and cigarette smokers are more or less the same as far as carcinoma of oral cavity, larynx and esophagus are concerned. Chewing tobacco or using snuff produces increased risk for oral cancers.

Cessation of smoking produces immediate and long-term physical, psychological and economic benefits. The sense of smell and taste may improve within a few days of quitting the cigarette.

One year after stopping, there is a decrease in risk for CHD; cessation also decreases risk for tobacco related cancers, cerebrovascular disease, MI and COPD.

Cessation Process[12]

Smokers should stop smoking in a stepwise process. First they think about quitting, and then they should maintain an ex-smoker status.

Most successful quitters replace and recycle through these stages 3-4 times before abstinence. Factors encouraging long-term cessation include decreased social acceptability, increased concern about health consequences and increased cost of tobacco.

Cessation Methods

Counselling, group therapy, behavioural training, hypnosis, and acupuncture are the methods tried.

Pharmacotherapy[13]

1. Nicotine containing chewing gum 2 or 4 mg chewed over 20-30 minutes, repeated up to 60 mg/day.
2. Transdermal nicotine patch; started as high does patch, 21 mg/day for 6 weeks followed by intermediate does patch, 14 mg/day for 2-4 weeks followed by low does patch, 7 mg/day for 2-4 weeks.
1. Nicotine nasal spray 2 sprays (equivalent to 1 mg) as needed not to exceed 5 doses /hr or 40 doses/ day.
2. Nicotine inhaler, 6-16 cartridges/day for 12 weeks followed by tapering over 6-12 weeks.
3. Bupropion hydrochloride.

It acts by inhibiting neuronal reuptake of Dopamine and nor adrenaline. The drug is started 1 week before quitting smoking at a does of 150mg orally OD for 3 days followed by 150mg orally BD for 7-12 weeks, increase smoking cessation rate when used with behaviour modification programme and can be combined with nicotine replacement.

Contraindication for Pharmacotherapy

- ★ Seizure disorder
- ★ Eating disorder like bulimia or anorexia nervosa.
- ★ Administration of MAO inhibitors.
- ★ Head trauma
- ★ CNS tumor
- ★ Concomitant antidepressants or antipsychotics
- ★ Hypersensitivity
- ★ Concomitant alcohol or benzodiazepines should be avoided.

Spirometry and Measurement

Definition

Spirometry is a test of lung function that measures how much and how quickly air can be moved into and out of the lungs. The measurements are made using a spirometer.

Spirometer

A spirometer is an instrument used to measure respired volumes and flows (i.e. Spirometry). Many spirometers are able to measure both Inspiratory and expiratory airflow.

Pulmonary function tests are undertaken to find out whether the patient has lung disease. The results of the pulmonary function tests of a given individual are compared with those obtained from a normal population of comparable height, age and gender. The test is considered abnormal if it falls outside the range based on the standard error of the estimate in which 95% of normal lies[14].

Pulmonary functions may be impaired due to physiologic and anatomic abnormalities. They are evaluated by pulmonary function tests. American Thoracic Society has recommended including forced Spirometry measurements and testing of single breath diffusing capacity[15] .

A recommended approach is to record maximal readings of forced expiratory volume in one second FEV_1 and FVC whether or not they are from the same tracing [16,17].

Peak of flow volume should be sharp. Peak expiratory flow rate (PEFR) is best non – invasive test of expiratory effort and should be proportional to FEV_1[18].

Spirometric parameters depend on weight, age, sex and race[19]. In India variations in values of Spirometry has been reported depending upon height, age, sex and socio economic status. Higher values have been reported in North Indians in comparison to Central India [20,21,22,23,24].

Uses of Spirometry

Correctly performed Spirometry, using an accurate spirometer provides:

- Rapid and objective assessment of airflow obstruction and restrictive conditions.
- Differentiation between asthma and COPD.
- Early detection and monitoring of disease progression (e.g. COPD).
- Quantitative assessment of the severity of airflow obstruction.
- Incorporate guideline recommendations for therapy based on COPD and asthma severity[25,26].
- Quantitative assessment of the response to therapy.

- Population screening and case finding to detect airflow obstruction – especially smokers and ex-smokers (with and without symptoms) and all patients with respiratory symptoms.
- Encouragement and motivation for smoking cessation, especially if abnormal Spirometry is obtained (provides a teachable moment').
- Feedback to the patient about their disease and effect of medication.
- More accurate and comprehensive assessment than peak flow.

Definitions of common spirometric indices

★ FVC (Forced Vital Capacity) is the maximum volume of air that can be expired (or inspired) during a maneuvers using maximal effort.

★ SVC (Slow Vital Capacity) is the maximum volume of air that can be exhaled "slowly" following a full inspiration (or inhaled after a complete expiration). The SVC is similar to the FVC in subjects without airflow obstruction, but is often larger in subjects with airflow obstruction.

★ FEV_1 (Forced Expired Volume in one second) is the volume of air that can be forcefully expired in the first second of the maximal expiration. It is a measure of how quickly full lungs can be emptied.

- ★ FEV_1/FVC ratio is the FEV_1 expressed as a percentage of the FVC and gives a clinically useful indicator of airflow obstruction.
- ★ $FEF_{25-75\%}$ (Forced Expiratory Flow between 25 and 75 percent of the FVC) is the average expired flow over the middle half of the FVC maneuvers. It is regarded as a more sensitive but more variable measure of narrowing of the smaller airways than provided by FEV_1.

How to perform Spirometry

Spirometry requires maximal effort from the patient and it takes time to perform quality Spirometry. It is essential the procedure is carefully and clearly explained and to actively persuade and motivate the patient to perform maximally. The volume and flow parameters measured are defined in terms of maximal effort and maximal exhaled volume. The performance of Spirometry while seated upright in a chair is preferable to standing as this is the most stable position should the patient experience dizziness during the test. The seated position is also preferable for patients with urinary incontinence who may otherwise limit the expiratory effort.

The key steps are to urge the patient to:

- ★ Breathe in fully (the lungs must be absolutely full).
- ★ Seal the lips around the mouth piece and blow immediately.
- ★ Blow the air out as fast and as far as possible until the lungs are completely empty.

- ★ Repeat the test until three acceptable and reproducible results are obtained (up to a maximum of 8 efforts)
- ★ The highest FEV_1 and FVC should be reported, even if they come from separate blows.

While it is not mandatory to use nose clips to prevent loss of measured volume through the nose, their use is sometimes of benefit.

Acceptable Results and Real-time Display

Acceptable results are those that were initiated at full lung inflation, and with maximum expiratory effort (e.g. No hesitation at the start and no pauses throughout the blow) until no more air can be expired. The results are reproducible if there is less than 200 ml variation in FEV_1 and FVC between the two best blows.

A spirometer that allows you to see a graph of the flow – volume curve in real time and provides alert messages about test quality makes it much easier to determine the acceptability of each blow. It is preferable to have both flow – volume and volume – time graphic outputs so that the acceptability of the results can be easily judged.

Common Causes of Poor Quality Spirometry

- Sub – maximal effort (e.g. Due to poor coaching, full bladder)
- Failure to fully inflate the lungs prior to performing the forced expiration.

- Incomplete expiration.
- Hesitation at the start of the expiration.
- Leaks (e.g. Between the lips and mouthpiece)
- Poorly calibrated / maintained spirometer.
- Untrained (or poorly) trained operator.
- Inability to comprehend the instructions.
- Cough
- Glottic closure
- Obstruction of the mouth piece by the tongue or teeth
- Vocalization during the forced maneuver
- Poor posture

Examples of poorly performed Spirometry are shown in Figure 1and 2.

Contraindications for Spirometry

Spirometry is a very safe procedure. However, it is physically demanding as it requires maximal patient effort and it involves the generation of high airway and intrathoracic pressures. It is advisable that Spirometry be delayed / abandoned for.

- Recent eye surgery
- Recent thoracic and abdominal surgery
- Aneurysms (e.g. Cerebral, abdominal)
- Unstable cardiac function
- Haemoptysis of unknown cause (e.g. TB)
- Pneumothorax

- Chest and abdominal pain
- Nausea and diarrhoea
- Inability to comprehend the instructions

Additionally children below the age of 7 years may have difficulty performing the test consistently.

Interpretive Strategies

Figure 3 shows a simple algorithm to guide the interpretation of Spirometry results. In the first instance, interpretation should be based on the FEV_1/FVC ratio. FEV_1, and FVC to determine if the results demonstrate normal, obstructive, restrictive or mixed patterns. Categorizing the severity of an obstructive defect should be based on the percent predicted FEV_1 rather than the FEV_1/FVC ratio.

There are three classifications for abnormal Spirometry (figure 4):

- **Obstructive Ventilatory Defect:** characterized by reduced expiratory flows e.g. Reduced FEV_1/FVC ratio, FEV_1, $FEF_{25-75\%}$ or if the expiratory flow volume curve is scooped out. common examples include asthma and COPD.

- **Restrictive Ventilatory Defect:** characterised by loss of lung volume in the absence of airflow obstruction – i.e. as suggested by a low SVC or FVC but normal or high FEV_1/FVC ratio. Examples include interstitial lung disease, respiratory muscle weakness, and thoracic cage deformities.

- **Mixed obstructive and Restrictive Ventilatory Defect:** characterized by both airflow obstruction and loss of lung volume. i.e. a low FEV_1/FVC ratio and low SVC or FVC. An example is cystic fibrosis.

Additionally, certain respiratory conditions alter the shape of the flow volume loop and it is important to learn how to recognise these. Examples are given in Figure 5.

The normal flow volume time curve shown together with examples of how respiratory disease can alter the shape of the flow volume relationship

a) Flow volume loop from a healthy subject.
b) Obstructive airway disease (e.g. asthma) before (shaded curve) and after (dashed line) the administration of a bronchodilator.
c) Severe obstructive disease (e.g. emphysema) before (shaded curve) and after (dashed line) the administration of a bronchodilator.
d) Restrictive lung disease (e.g. pulmonary fibrosis) – the predicted FVC is marked.
e) Fixed major airway obstruction (e.g. laryngeal obstruction).

Asthma and COPD

In these diseases FEV_1/FVC, and percent predicted FEV_1 are critical to detect and grade the severity of airflow obstruction, respectively and are used in the interpretation algorithm (figure 3). Although both asthma and COPD are characterised by airflow obstruction, the mechanisms of each disease are different in COPD due to emphysema, airway obstruction is predominantly due to airway collapse whereas in asthma it is mainly due to bronchoconstriction, inflammation of the airway wall and mucous plugging.

In general, Spirometry improves significantly after effective treatment in asthma but not at all, or only marginally, in patients with COPD although their symptoms may improve.

Reversibility of Airflow Obstruction

If there is evidence of airflow obstruction, Spirometry is usually performed and after the administration of a short – acting bronchodilator to assess whether the airflow obstruction can be reversed.

- Perform pre-bronchodilator Spirometry
- Administer the bronchodilator (e.g. 4 puffs of salbutamol via a spacer)
- Wait 10 minutes
- Perform post bronchodilator Spirometry

If the clinical reason for performing the reversibility test was to check the patient's usual response to bronchodilator, it may be more appropriate to use the patient's usual bronchodilator device and dose. During this test it is helpful to observe the patient's normal inhaler technique and correct any errors.

The American thoracic society recommends the following criteria for a significant improvement in Spirometry at least a 12% improvement in measured FEV_1 (or FVC) and an absolute improvement of atleast 200ml in either of these two measures.

It is important to note that in some patients the degree of reversibility can vary between clinic visits and will be reduced if the patient has taken a bronchodilator within prior to testing. It is important to ask the patient when

they last used their bronchodilator (short and long acting) and to take this into account when assessing the degree of reversibility.

The absence of significant reversibility does not necessarily exclude the diagnosis of asthma.

Note that the FEV_1/FVC ratio is not a reliable index of reversibility as the FVC can increase more than FEV_1 causing the FEV_1/FVC ratio to decrease in the presence of a useful degree of bronchodilatation. Do not use $FEF_{25-75\%}$ for assessing reversibility.

Reversibility may also be assessed by measuring Spirometry before and several weeks after a trial of inhaled.

Lung volumes and capacities (figure 7)

There are four lung volumes and four lung capacities[30].

Lung volumes[31]

1. **Tidal volume (TV)** – is the volume of air that is inhaled or exhaled from the lungs during effortless breathing.
2. **Inspiratory reserve volume (IRV) –** is the maximum volume of air that can be inhaled after the tidal volume is inhaled.
3. **Expiratory reserve volume (ERV) –** is the amount of gas that can be exhaled from the lungs after a normal quiet exhalation.
4. **Residual volume (RV) –** is the volume of gas remaining in the lungs after a complete maximal exhalation.

Lung capacities

In describing events of pulmonary cycle, it is desirable to consider two or more of the above volumes such combinations are called capacities. They are

a) **Inspiratory capacity (IC) –** is the maximum amount of gas that can be inhaled after a normal, effortless exhalation. The Inspiratory capacity is the sum of the tidal volume and Inspiratory reserve volume.

   IC = VT + IRV

b) **Functional residual capacity (FRC) –** is the amount of gas left in the lungs after a normal effortless exhalation at the resting expiratory level, the functional residual capacity equals. The sum of the expiratory reserve volume and the residual volume

   FRC = ERV + RV

c) **Vital capacity (VC) –** is the maximum amount of gas that can be exhaled after a maximum inhalation (or the maximum amount of gas that can be inhaled following a maximum exhalation). The vital capacity equals the sum of the Inspiratory reserve volume, the tidal volume and the expiratory reserve volume

   VC = IRV + VT + ERV

d) **Total lung capacity (TLC) –** is the maximum volume of gas in the lungs at the end of a maximum inhalation. The total lung capacity equals the sum of all four lung volumes.

   TLC = IRV + VT + ERV + RV

(or)

the sum of the vital capacity and the residual volume

TLC = VC + RV

(or)

the sum of the functional residual capacity and the respiratory capacity

TLC = FRC + IC

All pulmonary volumes and capacities are about 20-25% less in women than in men and they are obviously greater in large and athletic person than in small and asthenic persons.

Flow Rates

Forced Vital Capacity (FVC)

The maximum volume of air than can be expired or inspired during a forced expiratory maneuver initiated from TLC or RV.

Forced expiratory volume in 1 second (FEV_1)

It is the maximum volume of gas that the patient can exhaled during the first second of the forced vital capacity maneuver.

Forced expiratory volume in 3 seconds (FEV_3)

It is the maximum volume of gas that the patient can exhaled during the three seconds of the forced vital capacity maneuver

The forced expiratory volume in 1 second ratio (% FEV_1/FVC)

It is the percent of the measured forced vital capacity that can be exhaled in 1 second.

Peak expiratory flow rate (PEFR)

It is the maximum, greatest expiratory flow rate in L/sec. The forced expiratory flow between 200 ml and 1200 ml ($FEF_{200-1200}$) is a measure of the average expiratory flow during the early phase of exhalation; especially it is a measure of two flow rates for the 1000 ml of expired gas immediately following the first 200 ml of expired gas. This measurement is called the maximum expiratory flow rate (MEFR).

The forced expiratory flow between 25% and 75% of the Forced vital capacity ($FEF_{25-75\%}$)

It is a measure of the average expiratory flow during the middle half of the forced vital capacity.

The forced expiratory flow at 25% (FEF_{25}% or $Vmax_{25}$)

It is the maximum expiratory flow after 25% of the forced vital capacity has been exhaled.

The forced expiratory flow at 50% ($FEF_{50\%}$ or $Vmax_{50}$)

It is the maximum expiratory flow after 50% of the forced vital capacity has been exhaled.

The forced expiratory flow at 75% ($FEF_{75\%}$ or $Vmax_{75}$)

It is the maximum expiratory flow after 75% of the forced vital capacity has been exhaled. The forced Inspiratory flow at 50% (FIF 50%) of the vital capacity is the maximum Inspiratory flow after 50% of the forced vital capacity has been inspired.

The maximum voluntary ventilation (MVV) is the maximum value of air in liters per minute that a subject can breathe during a 12 to 15 second period. The MVV was called the maximum breathing capacity (MBC).

Although peak flow is largely a function of the caliber of the airway, it also greatly depends on expiratory muscle strength and on the patient's effort and coordination. As a result the measurement can be variable. In contrast high degrees of effort are not required to achieve maximum expiratory flow at intermediate and low lung volumes during forced expiration. Flow is often measured over the middle halt of the FVC ($FEF_{25-75\%}$=Maximum mid expiratory flow (MMEF) Because the flow does not include the initial, highly effort dependent portion of forced expiration, $FEF_{25\%-75\%}$ is often referred to as effort independent, values for $FEF_{25\%-75\%}$ in healthy young men average 4.5 to 5.0 L/sec. It is a sensitive indicator of early obstruction in the small distal airway[32] .

Measurement of diffusion capacity[33]

The diffusing capacity DL_{CO} is a measure of the lung's ability to transfer gas from alveoli to blood. The test utilizes uptake of carbon monoxide from a single breath of 0.3% mixture in air; this gas is chosen

because it combines rapidly with haemoglobin and provides a true estimate of diffusion across the alveolar capillary membrane.

The diffusion capacity is reduced in patients with disease principally affecting alveoli such as fibrosing alveolitis or emphysema. The transfer coefficient (K_{CO}) is a measure of diffusing capacity expressed per volume of ventilated lung during the single breath test and is useful to contain that a low DL_{CO} is due to alveolar disease rather than maldistribution of ventilation. High values of DL_{CO} may be seen in alveolar haemorrhage.

Arterial blood gas

The most commonly used measures of the gas exchange are the partial pressure of O_2 and CO_2 in arterial blood i.e. PaO_2 and PaO_2. These partial pressures do not measure directly the quantity of O_2 or CO_2 in blood but rather the driving pressure for the gas in blood.

Pulse Oximetry

Measures oxygen saturation rather than PaO_2 by using a probe clipped over patients finger. The device measures two wave lengths of light reflected by hemoglobin via pulsatile, cutaneous arterial blood. Because of differential absorption of the two wave lengths of light by oxygenated and non oxygenated haemoglobin, the percentage of haemoglobin that is saturated with O_2 i.e. the SaO_2 can be calculated and displayed instantaneously.

MATERIALS AND METHODS

MATERIALS AND METHODS

This is a cross sectional, case control study conducted at Govt. Rajaji Hospital, Madurai between July 2005 to June 2006. The study was conducted on patients attending Medical OPD of Govt. Rajaji Hospital (GRH), Madurai.

The study population was divided into four groups.

1. Group I consist of patient who smoked less than 20 pack years and attended OPD for respiratory or non respiratory symptoms.
2. Group II consist of patient who smoked 20-30 pack years and attended OPD for respiratory or non respiratory symptoms.
3. Group III consist of patient who smoked 30 pack years and attended OPD for respiratory or non respiratory symptoms.
4. Control group consists of non smokers with in the age group of 30 to 65 years.

Inclusion Criteria

Chronic male smokers who smoked for more than 10 years and age between 30 years to 65 years, irrespective of whether respiratory symptoms were present or not, were included in the study.

Exclusion Criteria

1. Obesity
2. Anaemia
3. Chest wall deformity – kyphosis, scoliosis, ankylosing spondylitis

4. Bronchial asthma
5. Current / past pulmonary tuberculosis
6. Patients with occupation prone to develop occupational lung disease
7. Hypothyroidism
8. Severe disease interfering with performance of pulmonary function test

The selected patient were evaluated with a detailed history regarding duration of smoking, type of smoke, quantity, occupation history, drug history, respiratory symptoms like cough, expectoration, breathlessness.

A detailed respiratory system examination with special attention to breath sound, crepitations and wheeze was done.

The following basic investigation was done for all patients.

1. Total WBC count
2. Differential count
3. Haemoglobin in Gm%
4. Sputum examination for AFB
5. Chest X Ray
6. ECG

After assessing these baseline clinical and laboratory parameters, the chronic smokers and control group were subjected to computerized spirometric evaluation.

All the spirometric parameters were expressed as percentage of predicted value for that particular age, sex, height and weight comparable to South Indian Population defined by Knudsen et al.

All the tests were repeated on three occasions and the best of the three reading are taken.

Among the various spirometric parameters, the following were analysed.

1. Forced vital capacity (FVC)
2. Forced Expiratory Volume in First Second (FEV_1)
3. Percentage of FVC, expelled as FEV_1

$$\frac{FEV_1}{FVC} \times 100$$

4. Forced expiratory flow rate 50% the total FVC (FEF_{50})
5. Forced expiratory flow rate between 25% and 75% of total FVC ($FEF_{25-75\%}$) also called maximal mid expiratory flow rate (MMEFR).

The Spirometry was performed using Knudsen's computerized spirometer.

Interpretation

The spirometric values are interpreted as pulmonary dysfunction in one of the following categories. Because there is some variability in normal individuals, values between 80% and 120% are considered normal and values

of individual measurement falling below the fifth percentile are considered to be below normal.

- Normal value for FEV_1 is around 83% [34]
- Normal value for FEV_1/FVC is 75-85%
- The $FEF_{25-75\%}$ is often considered a more sensitive measurement of early small airway obstruction.

Spirometric assessment allows categorization of pulmonary dysfunction into

1. Obstructive pattern
2. Restrictive pattern
3. Mixed pattern

Pattern	**FEV_1**	**FVC**	**FEV_1/FVC**
Obstructive	Decreased	Normal (80-120%)	Decreased (<75%)
Restrictive	Normal (or) Decreased	Decreased (<80%)	Normal or Increased (>75%)
Mixed	Normal or decreased	Decreased (<80%)	Decreased (<75%)

Obstructive pattern is further classified according to GOLD[35,36,37] Criteria (GOLD = Global Initiative for Chronic Obstructive Lung Disease).

GOLD Criteria consist of four categories as follows[38]

GOLD Stage	**Severity**	**Symptoms**	**Spirometry**	
			FEV_1/FVC	**FEV_1%**
0	At risk	Chronic cough, sputum production	Normal	
I	Mild	With or without chronic cough or sputum production	< 0.7	≥80% predicted
II	Moderate	With or without cough or sputum production	< 0.7	50%-30% of predicted
III	Severe	With or without chronic cough or sputum production	< 0.7	30%-50% of predicted
IV	Very severe	With or without chronic cough or sputum production	1. <0.7	<30% of predicted
			Or 2. FEV_1< 50% of predicted with respiratory failure or signs of right heart failure.	

Limitation of this study

- Though carefully designed and meticulously carried out the study is subjected to subject (patient) error, instrument error and investigators error.
- Since this study, does not include hospitalized, seriously ill patient, the magnitude of smoking related lung problems is not completely known.

Statistical analysis

Computer Analysis of Statistical data was done utilizing Epidemiological Information Package (EPI 2005) developed by World Health Organisation. Frequencies, percentages, mean, S.D. and ‘p’ values were calculated using this package.

If the value of ‘p’ is less than <0.05, it is considered to be significant.

Statistical Analysis of Pulmonary Function Test in Chronics Smoker

The study population consists of Four Groups

- ★ Group I : 36 smokers of 11-20 pack years.
- ★ Group II : 50 smokers of 21-30 pack years.
- ★ Group III : 64 smokers of > 30 pack years.
- ★ Group IV : 50 non smokers as control

Among the 36 smokers in Group I, all of them had normal pulmonary function test. There mean FEV_1, were 85.1% mean FVC were 106.2%, mean FEV_1/FVC were 80.2%, Mean FEF_{50} were 84.6% and mean FEF_{25-75} were 84.6%.

Among the smokers in Group II, 41 (82%) had normal pulmonary function test, 8(16%) had GOLD Stage I airflow obstruction, 1(2%) had GOLD Stage II airflow obstruction. There mean FEV_1 were 84.6% mean FVC were 110.1%, Mean FEV_1/FVC were 77.1%, Mean FEF_{50} were 81.9% and mean FEF_{25-75} were 82.2%.

Among the 64 smokers in Group III, 30 (46.8%) had normal pulmonary function test, 21 (32.8%) had GOLD stage I airflow obstruction, 6

(9.4%) had GOLD stage II airflow obstruction, 4 (6.3%) had restrictive pattern and 3 (4.7%) had mixed pattern. The mean FEV_1, were 80.8%, Mean FVC were 107.5%, Mean FEV_1/FVC were 76.4%, mean FEF_{50} were 80.2%, Mean FEF_{25-75} were 80.3%.

Among the 50 non smokers in Group IV, 48 (96%) had normal pulmonary function test and 2(4%) had GOLD stage I airflow obstruction. There mean FEV_1, were 82.5%, Mean FVC_1 were 106.6%, Mean FEV1/FVC were 78.8, Mean FEF_{50} were 81.7% and Mean FEF_{25-75} were 81.4%.

If all the smokers including normal PFT and abnormal PFT were considered there mean FEV_1 were 83.11%, Mean FVC were 108.06%, Mean FEV_1/FVC were 77.55% and Mean FEF_{50} were 81.82% and Mean FEF_{25-75} were 82.0%.

Similarly nonsmokers including normal PFT and abnormal PFT were considered there mean FEV_1, were 82.53%, Mean FVC were 106.6%, Mean FEV_1/FVC were 78.8%, Mean FEF_{50} were 81.74 and mean FEF_{25-75} were 81.44%..

RESULTS

RESULTS

A. Comparison of parameters in the Study Group (Chronic Smokers) and Control Group (Non Smokers).

Table 1

Age distribution of study groups and control groups

Age Group	Study Group (Smokers)		Control Group (Non Smokers)	
	No	**%**	**No**	**%**
< 40	29	19.3	6	12
41 – 50	33	22.0	14	28
51 – 60	57	38.0	16	32
> 60	31	20.7	14	28
Total	150	100	50	100
Mean	50.7 yrs		53.6 yrs	
S.D	10.4		10.9	
P	0.1818			

There is no statistically significant difference in the age composition of the two groups.

Table : 2

Coughing in Smoker and Non smokers

Cough	Study Group (Smokers)		Control Group (Non Smokers)	
	No	**%**	**No**	**%**
Present	46	30.7	5	10
Absent	104	69.3	45	90

‘P = 0.0066 (Significant)

The percentage of persons reporting cough is more in smokers then in non-smokers. The difference is statistically significant

Table :3

Mean FEV_1, FVC, FEV_1/FVC % FEF_{50} and FEF_{25-75} of smokers and non smokers

Parameter	Smokers		Non Smokers		P
	Mean	S.D	Mean	S.D	
FEV_1 %	83.11	5.97	82.53	6.0	0.3199
FVC %	108.06	10.07	106.6	13.12	0.9944
FEV_1/FVC%	77.55	8.98	78.8	5.78	0.7264
FEF_{50}	81.82	5.57	81.74	5.78	0.9616
FEF_{25-75}	82.0	5.77	81.44	5.79	0.5181

There is no statistically significant difference in the pulmonary function parameters of smokers and nonsmokers.

Table 4

Pulmonary function status of smokers and non smokers

Pulmonary function Status	Smokers		Non Smokers (control)	
	No.	%	No.	%
Normal	107	71.3	48	96
GOLD stage I	29	19.3	2	4
GOLD Stage II	7	4.7	-	-
Restrictive	4	2.7	-	-
Mixed	3	2	-	-
Total	150	100	50	100

'p' = 0.0006

There is statistically significant difference in the pulmonary function status of smokers and nonsmokers.

B. Characteristics of the Study Group

Table 5

Pack years of smokers

Pack Years	Smokers	
	No.	**%**
11-20	36	24
21-30	50	33.3
>30	64	42.7
Total	150	100
Mean S.D.	30.8 12.8	

The mean pack years of the smokers were 30.8.

Table 6

Distribution of pulmonary function

status in smokers

Pulmonary function Status	**smokers**	
	No.	**%**
Normal	107	71.3
GOLD stage I	29	19.3
GOLD Stage II	7	4.7
Restrictive	4	2.7
Mixed	3	2
Total	150	100

Among the smokers studied, 28.7% had abnormal pulmonary function status.

Table7

Mean FEV_1, FV_C, FEV_1/FVC (%), FEF_{50} and FEF_{25-75} of smokers

Parameter	Smoker	
	Mean	**S.D.**
FEV_1 %	83.1	6
FVC %	108.1	10.1
FEV_1/FVC %	77.5	9
FEF_{50}	81.8	5.6
FEF_{25-75}	81.9	5.6

C. Relationship of parameters in the Study Group

Table 8

Age and Pack years

Age Group	Pack Years							
	11-20		21-30		>30		Total	
	No.	%	No.	%	No.	%	Mean	S.D.
31-40	18	50	10	20	1	1.6	19.2	6.2
41-50	11	30.6	11	22	11	17.2	26.1	9.2
51-60	4	11.1	19	38	34	53.1	36.4	12.2
>60	3	8.3	10	20	18	28.1	36.3	13
Total	36	100	50	100	100	100	30.8	12.8
'p'	**0.0001**							

Statistically significant relationship exists between age and pack years. It is highest in the 'more than 50' age group.

Table 9

Age and pulmonary function status

Age Group	Pulmonary function status											
	Normal		Stage I		Stage II		Restrictive		Mixed		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
31-40	26	24.3	2	6.9	1	14.3	-	-	-	-	29	19.3
41-50	24	22.4	7	24.1	1	14.3	1	25	-	-	33	22
51-60	38	35.5	12	41.4	3	42.9	2	50	2	66.7	57	38
>60	19	17.8	8	27.6	2	28.6	1	25	1	33.3	31	20.1
Total	107	100	29	100	7	100	4	100	3	100	150	100
Mean age	49.0		55.3		56.0		60.0		63.3		51.2	
S.D.	10.8		10.1		11.3		9.4		10.1		11.1	
p	0.0056											

Abnormal pulmonary function was more prevalent in the older age group than the younger age group and this difference was statistically significant.

Table 10

Mean values of FEV_1, FVC, FEV_1/FVC, FEF_{50} and FEF_{25-75} in different age groups

Age Group	FEV_1		FVC		FEV_1/FVC		FEF_{50}		FEF_{25-75}	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
31-40	84.5	4.3	108.3	5.6	78.1	5.3	83.3	4.6	83.2	4.4
41-50	83.4	5.7	108.7	9.3	77.2	8.2	81.8	5.4	82.2	6.1
51-60	82.7	6.8	107.5	11.8	77.7	10.3	81.6	6	81.6	6.1
>60	82.4	6	108.1	11	77	10.3	80.9	5.8	81.2	6.5
Total	83.6	6	108.1	10.1	77.5	9	81.8	5.6	81.9	5.9
p	0.2605		0.8185		0.6836		0.6001		0.7307	

The value of the parameters has no significant relationship with the age of the respondents.

Table 11

Pack Years and Pulmonary function status

Pack years	Pulmonary function Status											
	Normal		Stage I		Stage II		Restrictive		Mixed		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
11-20	36	33.6	-	-	-	-	-	-	-	-	36	24
21-30	41	38.3	8	27.6	1	14.3	-	-	-	-	50	33.3
>30	30	28	21	72.4	6	85.7	4	100	3	100	64	42.7
Total	107	150	29	100	7	100	100	100	3	100	150	100
Mean pack years	26.4		39.0		42.9		51.6		53.3		30.8	
S.D.	10.4		10.7		10.7		15.6		5.8		12.8	

P = 0.0001

Severity of the obstruction is significantly affected by the pack years of the respondents.

Table 12

Mean values of FEV_1, FVC, FEV_1/FVC, FEF_{50} and FEF_{25-75} and pack years of smokers

Pack years	FEV_1		FVC		FEV_1/FVC		FEF_{50}		FEF_{25-75}	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
11-20	85.1	1.8	106.2	502	80.2	3.0	84.6	3.1	84.6	3.2
21-30	84.6	3.4	110.1	506	77.1	5.3	81.9	4.9	82.2	5.1
>30	80.8	8.0	107.5	14.0	76.4	12.6	80.2	6.5	80.3	7.0
Total	83.1	6.0	108.1	10.1	77.5	9.0	81.8	5.6	81.9	5.9
P	0.0002		0.0061		0.0003		0.0122		0.0384	

There exists statistically significant relationship between the pack years and the pulmonary function parameters.

Table 13

Mean values of FEV_1, FVC, FEV_1/FVC, FEF_{50} and FEF_{25-75} in smokers with abnormal pulmonary function status

Pulmonary function Status	FEV_1		FVC		FEV_1/FVC		FEF_{50}		FEF_{25-75}	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Normal	85.5	1.7	108	5.2	79.3	3.0	84.6	2.8	84.7	3.1
Stage I	81.2	0.8	118.2	1.5	68.7	1.1	74.3	0.8	74.0	1.0
Stage II	59.8	6.2	102.2	7.5	58.4	2.1	72.8	1.7	72.6	1.7
Restrictive	77.3	1.7	72.6	1.6	106.3	2.9	83.5	1.0	84.5	3.5
Mixed	77.9	0.9	73.3	0.9	106.5	2.1	87.3	2.1	88.0	2.6
Total	83.1	6.0	108.1	10.1	77.5	9.0	81.8	5.6	89.9	5.9
P	0.0001		0.0001		0.0001		0.0001		0.0001	

‘p’ = 0.0001 (Significant).

Table 14

Reporting of coughing in patients with different Pulmonary Function status

Pulmonary function Status	Coughing				Total	
	Present		Absent			
	No.	%	No.	%	No.	%
Normal	26	24.1	81	75.7	107	100
GOLD Stage I	14	48.3	15	51.7	29	100
GOLD Stage II	4	57.1	3	42.7	7	100
Restrictive	2	50	2	50	4	100
Mixed	1	33.3	2	66.7	3	100
Abnormal Total	21	48.8	22	51.2	43	100

P = 0.0062 (Significant).

Gold stage II airflow obstruction and Restrictive lung disease smokers had more cough than other group.

DISCUSSION

DISCUSSION

Chronic obstructive pulmonary disease is characterized by the presence of chronic bronchitis and/or emphysema, which are mostly due to cigarette smoking. Airways and parenchyma are primarily affected regions showing the pathologic changes in the lungs. Spiro metric decline found to be related to the severity of COPD (Mehmet Polath et al) [39].

In this study 150 male smokers [(Mean age 50.7 years (SD 10.4)] and 50 male nonsmokers [(Mean age 53.6 years (SD 10.9] were studied recording pulmonary function test using spirometry. There were no statistically significant differences in the age composition of the two-study group. They came to the hospital for minor ailment.

Airflow obstruction were catogarized according to GOLD Criteria. Among the smoker studied 28.7% had abnormal pulmonary study pattern, 71.3% had normal pulmonary function. This study was comparable to study conducted by Murrey RP et al[40]. In their study of 70,000 chronic smokers about 25% were found to have borderline to moderate airflow obstruction, additional 5% had severe airflow obstruction.

In this study, out of the 28.7% abnormal pulmonary function pattern, 19.3% were in GOLD stage I airflow obstruction, 4.7% were in GOLD stage II airflow obstruction, 2.7% were in restrictive pulmonary pattern and 2% were in mixed pulmonary pattern. So most of the abnormality fall in GOLD stage I air flow obstructive pattern. Non of the smoker in this study were in GOLD stage III or IV. Previously undetected abnormal lung function in chronic smoker was detected of having abnormal pulmonary function pattern by using spirometry.

Roeland MM Geijer et al[41] in their study of 702 chronic smoker, he had found 29.9% had abnormal pulmonary function test out of which mild airflow obstruction (GOLD Stage I) were in 25.9% and moderate airflow obstruction (GOLD stage II) were in 4%. This study was comparable to our study.

Among the nonsmoker studied (control) 96% had normal lung function test and 4% had GOLD stage I airflow obstruction. So there were statistically significant difference in pulmonary function status of smoker and nonsmokers. Smoker had abnormal pulmonary function more commonly then nonsmokers. Among the smokers obstructive airflow disease were more common than restrictive lung disease. This was compatible to Roeland MM heijer et al's study.

In this study 24% of the smoker fall in 11-20 pack year category (Group-I), 33.3% of the smoker fall in 21-30 pack year category (Group II) and 42.7% of the smoker fall in >30 pack year category (Group III). The mean pack years of the smokers were 30.8 pack years.

In this study: 31-40 yrs age group most of the smoker were smoked for 11-20 pack years (50%), 41-50yrs age group most of the smoker were smoked 11-20 pack years (30.6%), in 51-60 yrs age group most of them were smoked >30 pack years (53.1%), > 60years age group most of them had smoked > 30 pack years (28.1%). There was statistically significant relationship exists between age and pack years. Pack years is highest in above 50 age group. It indicates as age increases number of pack years also increases.

In the present study, in age group 31-40 years (total 29) 26 had normal pulmonary function status, 2 had GOLD stage I airflow obstruction, 1 had GOLD stage II airflow obstruction. In age group 41-50 years (Total33) – 24 had normal pulmonary function, 7 had GOLD stage I airflow obstruction, 1 had GOLD stage II airflow obstruction, 1 had restrictive pattern.

In age group 51-60 yrs (total 57) – 38 had normal pulmonary function, 12 were GOLD stage I airflow obstruction, 3 were in gold stage II airflow obstruction, 2 were restrictive lung disease, 2 had mixed disease.

In age group > 60 yrs (total 31) – 19 were in normal,8 were in GOLD stage I airflow obstruction, 2 were in GOLD stage II airflow obstruction, 1 had restrictive lung disease. 1 had mixed lung disease.

Airway obstruction was more prevalent in the old age group (>50 years) the younger age group (<50years) and this difference was statistically significant.

Alfred PE Sachs et al[42] in his study he found in the older age group (>55yrs) airflow obstruction (GOLD 1 or higher) was found in 45% verses 21% in the youngest age group (40-44yrs) our study correlate with his observations.

In this study, among the smokers (150), 36 smokers were in the 11-20 pack years group (24%) and they had normal pulmonary function status. 50 smokers had 21-30 pack years group, out of whom 41 had normal pulmonary function. 8 had GOLD stage I airflow obstruction only one and I had GOLD Stage II airflow obstruction.

In more than 30 pack years group, 64 smokers were present in total out of whom 30 had normal pulmonary study. 21 had GOLD stage I airflow

obstruction, 6 had GOLD stage II airway obstruction 4 had restrictive pattern 3 had mixed abnormality.

As the pack years increases, lung function abnormality become more obivious. It is statistically significant.

Connett JE et al[43] in his study he found that > 20 pack years of cigarette smoking was major risk factor for COPD.

Jan willem J. Lamves et al[44] in his study he noted smokers > 30, pack years the prevalence of airflow obstruction was 45% verses 20% among those with <20 pack years.

In the over all smokers population in this study (150)

- ★ 107 smokers had normal function test. In them 77 (71.9%) in < 30 pack years group. 30 (28%) smoker were >30 pack years group.
- ★ 29 smoker had GOLD stage I airflow obstruction, out of which 8 (27.6%) were in <30 each years group, 21 (72.4%) were in > 30 pack years group.

- ★ 7 smoker had GOLD stage II airflow obstruction, out of which 1 (14.3%) were in < 30 pack years group, 6 (85.7%) were in > 30 pack years group.
- ★ 4smokers had Restrictive pattern all of them were > 30 pack year group.
- ★ 3 smoker had mixed pattern, all of them were >30 pack years group.

From this observation < 20 pack years non of the smokers had significant lung function abnormality, 21-30 pack years had predominantly GOLD stage I airflow obstruction, > 30 pack years had predominantly GOLD State I airflow obstruction followed by GOLD stage II airflow obstruction. Restrictive pattern and mixed pattern were seen only in >30 pack years group.

In the smoker group (150) 47 smoker complaint of cough (31.3%) and 103 smoker did not have cough.

- ★ 26 smokers (24.1%) with normal lung function test had cough.
- ★ 14 (48.3) out of 29 GOLD stage I had cough, 4 (57.1%) out of 7 GOLD stage II airflow obstruction had cough.
- ★ 2 (50%) out of 4 smoker in restrictive in restrict pattern had cough.
- ★ 1(33.3%) out of 3 smoker in mixed pattern had cough.

From this observation, in GOLD stage II air flow obstruction and restrictive lung disease pattern had more cough than other group.

In the 107 smoker with normal pulmonary function test 81(75.7%) did not have cough, but 26 smoker (24.1%) had cough. Even with out airflow obstruction, person who had smoking habit had cough.

Arno W Hoes et al[45], in their study smoker reporting coughing the prevalence was 47% versus 25% in those not reporting this symptom.

In out study smoker reporting coughing the prevalence was 44.6% versus 21.3% in those not reporting this symptoms. It was comparable to previous study.

David. A. Kaminsky et al, Theodore W. Marcy et al[46] they found those smokers who had moderate and severe airflow limitation on spirometric screening were more likely to have quit smoking compared to those with mild or no airflow limitation. The authors concluded that the diagnosis of airflow limitation motivated smokers to attempt to quit smoking.

J.E. connett et al[47] in their study of 3926 smoker with mild-moderate airflow obstruction, concluded that smoker airflow obstruction benefit from quitting despite previous heavy smoking, advanced age, poor base line lung function or airway hyper responsiveness.

CONCLUSION

CONCLUSION

1. High prevalence of pulmonary function abnormalities (28.7%) was seen in chronic smokers.

2. GOLD stage I airflow obstruction was observed in 19.3% of the chronic smokers.

3. Gold stage II airflow obstruction was observed in 4.7% of the chronic smokers.

4. Restrictive pulmonary pattern was observed in 2.7% of the chronic smokers.

5. Mixed pulmonary pattern was observed in 2% of the chronic smokers.

6. Smoker had abnormal lung function more commonly than nonsmokers.

7. Pack years of smoking was highest in >50yrs age group. As age increases number of pack years also increases.

8. Airflow obstruction was more prevalent in the old age group (>50yrs) than the <50 yrs group.

9. As the pack years increases lung function abnormality also increases.

10. Restrictive pattern and mixed pattern were seen in >30 pack years smoker group only.

11. Gold stage II airflow obstruction and Restrictive lung disease smokers had more cough than other group.

12. Among the smoker who had abnormal pulmonary function test 48.8% had complaints of cough.

In summary, spirometry detects undetected pulmonary function abnormality – both airflow obstruction and restrictive lung disease in the chronic smokers.

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PROFORMA

PROFORMA

PULMONARY FUNCTION TEST IN CHRONIC SMOKERS

Name :

Age :

Sex :

Occupation :

Smoking Habit :

Type :

Cigarettes

Cigar

Beedi

Address :

Duration

Height :

Weight :

Quantity

Symptoms

Cough

Expectoration

Hemoptysis

Wheezing

Chest pain

Sign

Pallor

Erythrocytosis

Clubbing

Obesity

Malnutrition

Fever

Tachycardia

Cor pulmonale

AUSCULATORY FINDING

CVS

RS

Co-existing disease

Lung disease

a. Bronchial asthma
b. Tuberculosis
c. ILD
d. Pleural effusion

CVS

e. CHD
f. IHD
g. HT

CNS

h. Disorientation
i. Mental State
j. Intoxication

Endocrine

k. Hypothyroidism
l. Diabetes

Orthopedic

m. Kyphoscohosis
n. Chest wall deformity

Connective tissue disorder

o. Ankylosing spondylosis

p. Rhematoid arthritis

q. SLE

Malignancy

II. Renal Disease

Investigation

1. Hb
2. TC
3. DC
4. Sputum AFB
5. X-ray Chest
6. ECG

Spirometry

Spirometric Parameter	% of predicted value
FEV_1	
FVC	
FEV_1/FVC	
$FEF_{50\%}$	
$FEF_{25-75\%}$	

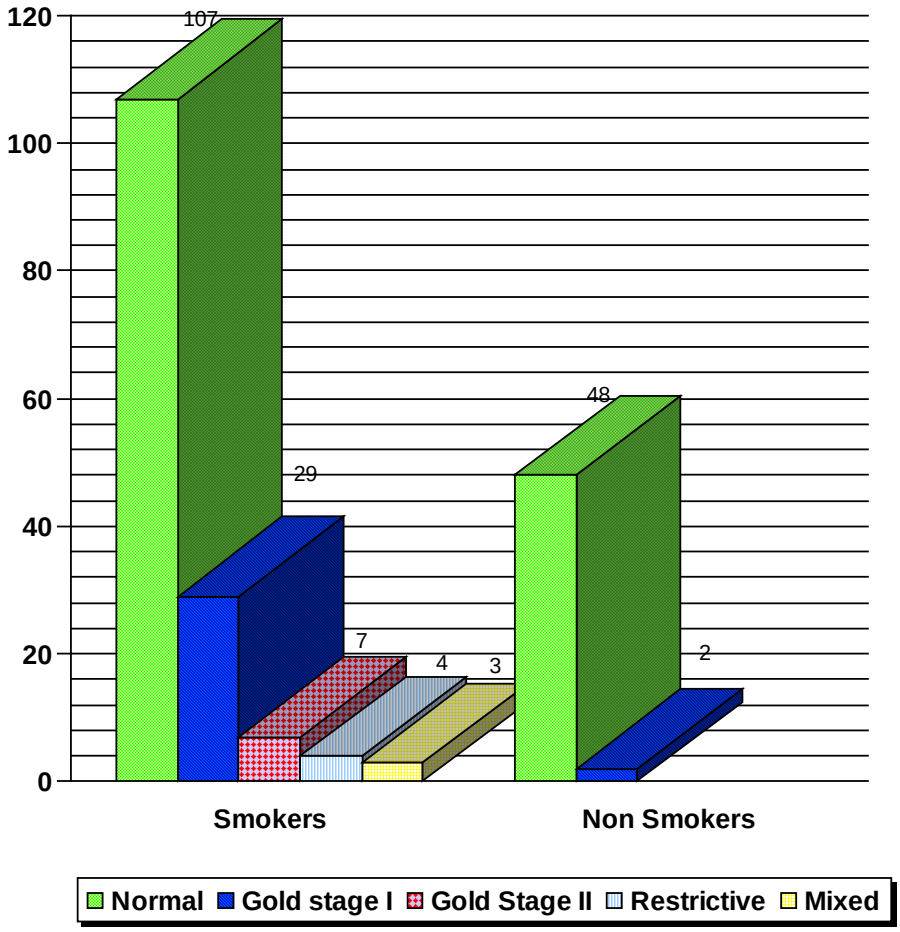
ABBREVIATIONS

ABBREVIATIONS

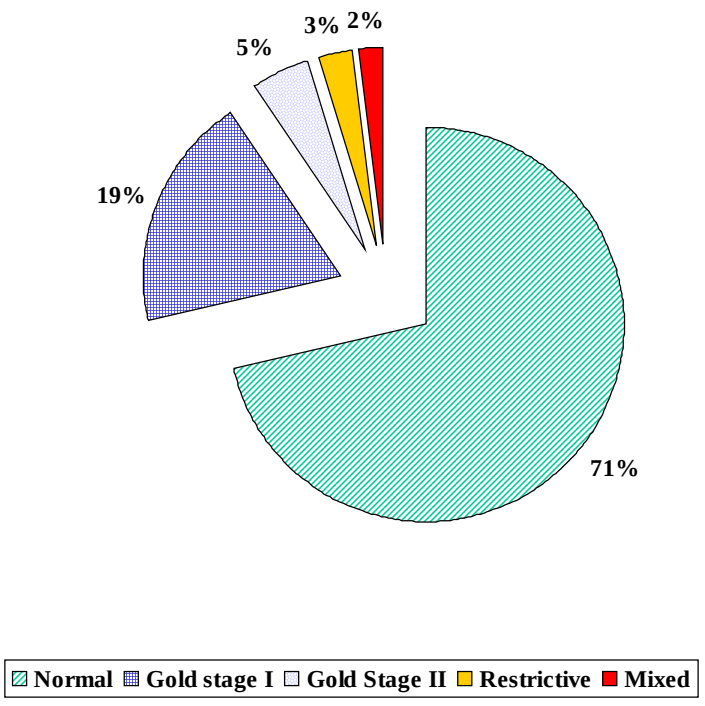
COPD	-	Chronic Obstructive Pulmonary Disease
CHD	-	Coronary Heart Disease
CNS	-	Central Nervous System
DLco	-	Diffusing Lung Capacity for Carbon Monoxide
ERV	-	Expiratory Reserve Volume
FEV_1	-	Forced Vital Capacity in one second
$FEF_{50\%}$	-	Forced Expiratory Flow at 50% of Vital Capacity
$FEF_{25\text{-}75\%}$	-	Forced Expiratory Flow at 25to75% of Vital Capacity
$FIF_{50}\%$	-	Forced Inspiratory Flow at 50% of Vital Capacity
FRC	-	Functional Residual Capacity
FVC	-	Forced Vital Capacity
GOLD	-	Global Initiative for Chronic Obstructive Lung Disease
HDL	-	High Density Lipoprotein
IRV	-	Inspiratory Reserve Volume
IC	-	Inspiratory Capacity
ILD	-	Interstitial Lung Disease
IHD	-	Ischemic Heart Disease
LDL	-	Low Density Lipoprotein
MBC	-	Maximum Breathing Capacity
MI	-	Myocardial Infarction

MMEFR	-	Mid Maximal Expiratory Flow Rate
MVV	-	Maximum Voluntary Ventilation
PEFR	-	Peak Expiratory Flow Rate
PFT	-	Pulmonary Function Tests
RV	-	Residual Volume
SVS	-	Slow Vital Capacity
TAO	-	Thromboangitis obliterans
TLC	-	Total Lung Capacity
TV	-	Tidal Volume
VC	-	Vital Capacity

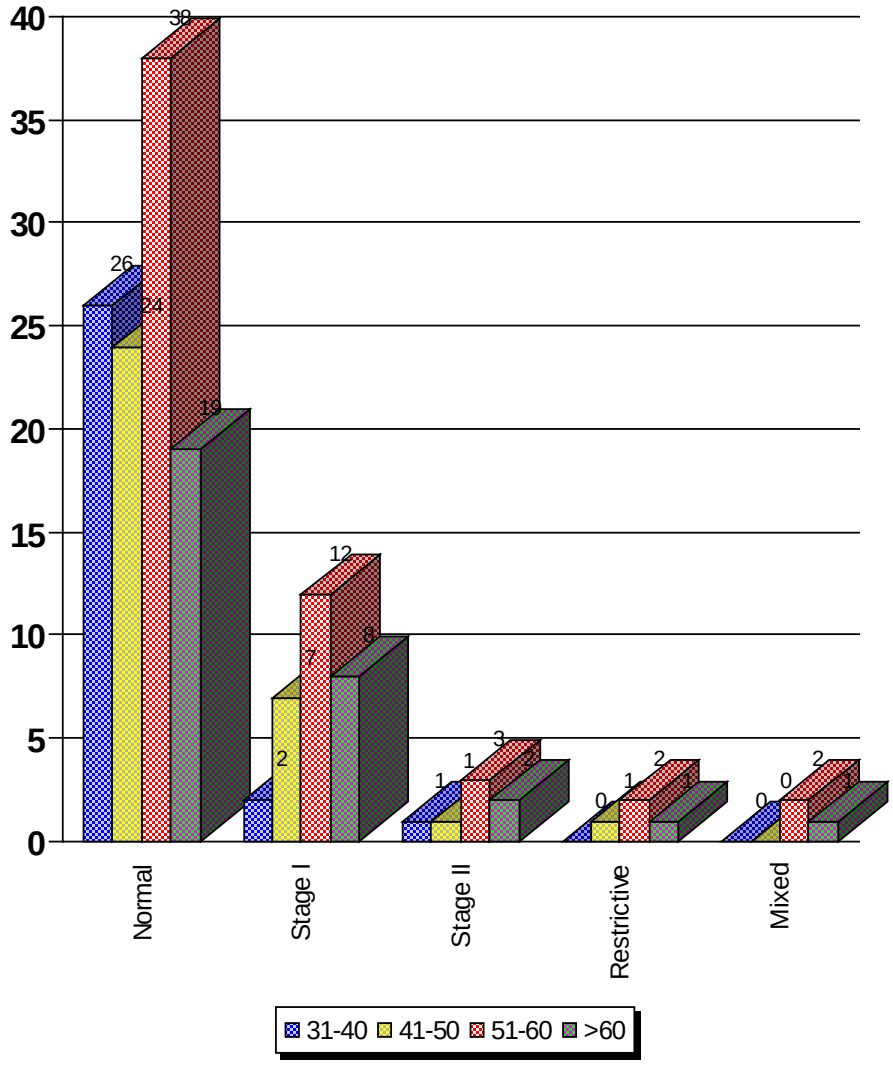
Pulmonary function status of smokers and non smokers



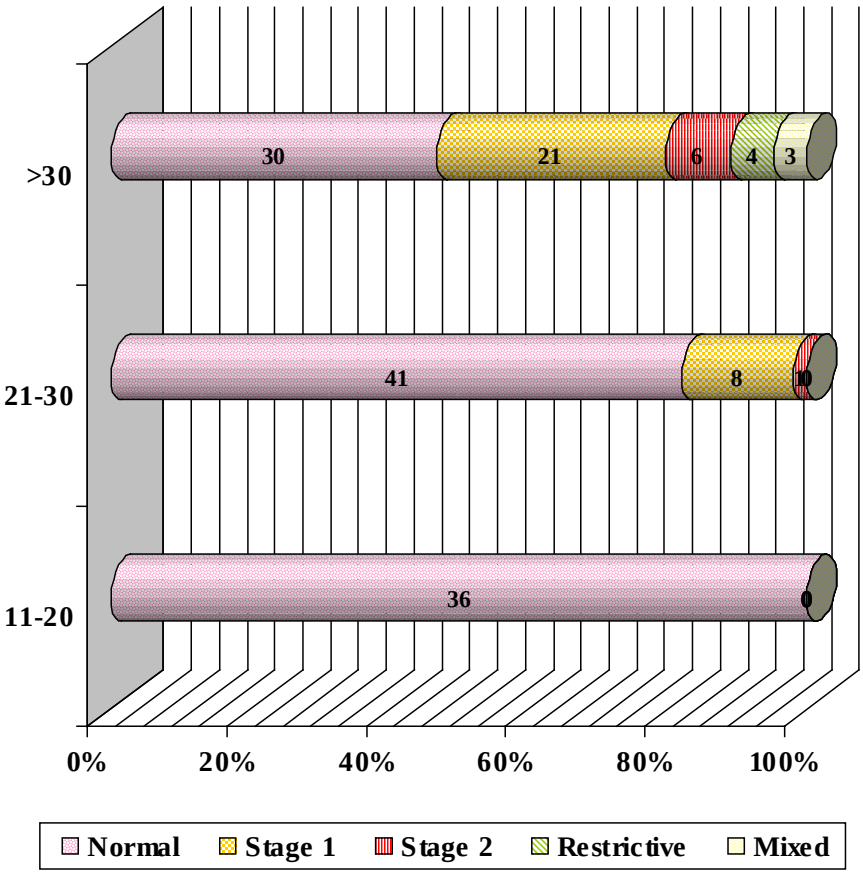
Distribution of pulmonary function status in smoker



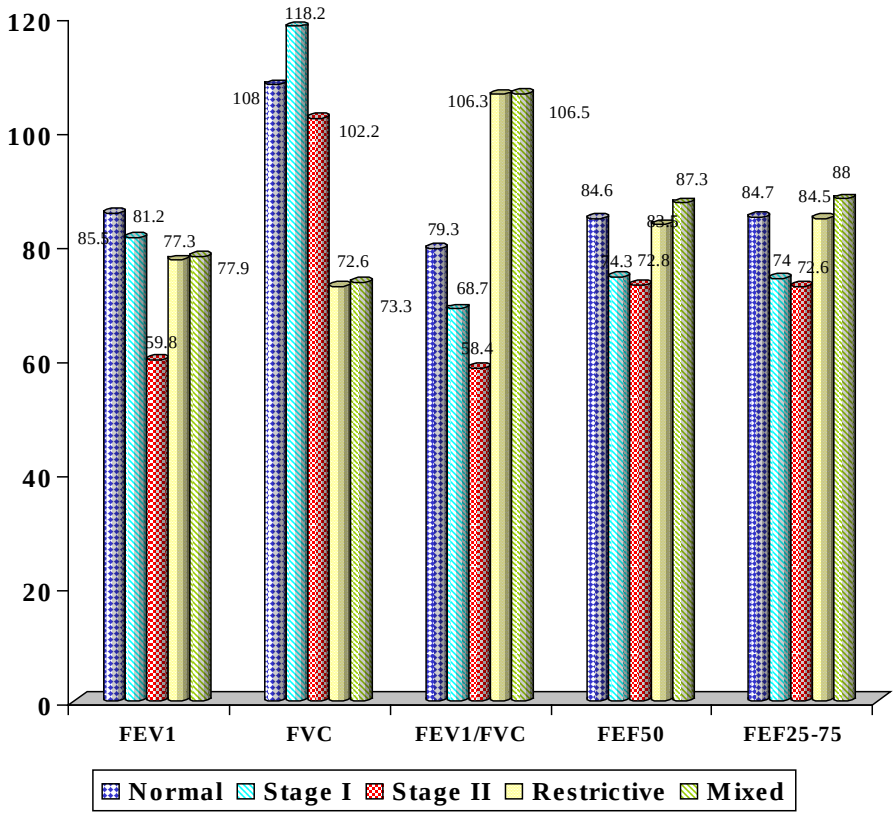
Age and pulmonary function status of smokers



Pack Years and pulmonary function status of smokers



Mean values of FEV_1, FVC, FEV_1/FVC, FEF_{50} and FEF_{25-75} in smokers with abnormal pulmonary function status



SPIROMETRY

SMOKER PERFORMING SPIROMETRY

FIGURES

Figure 1

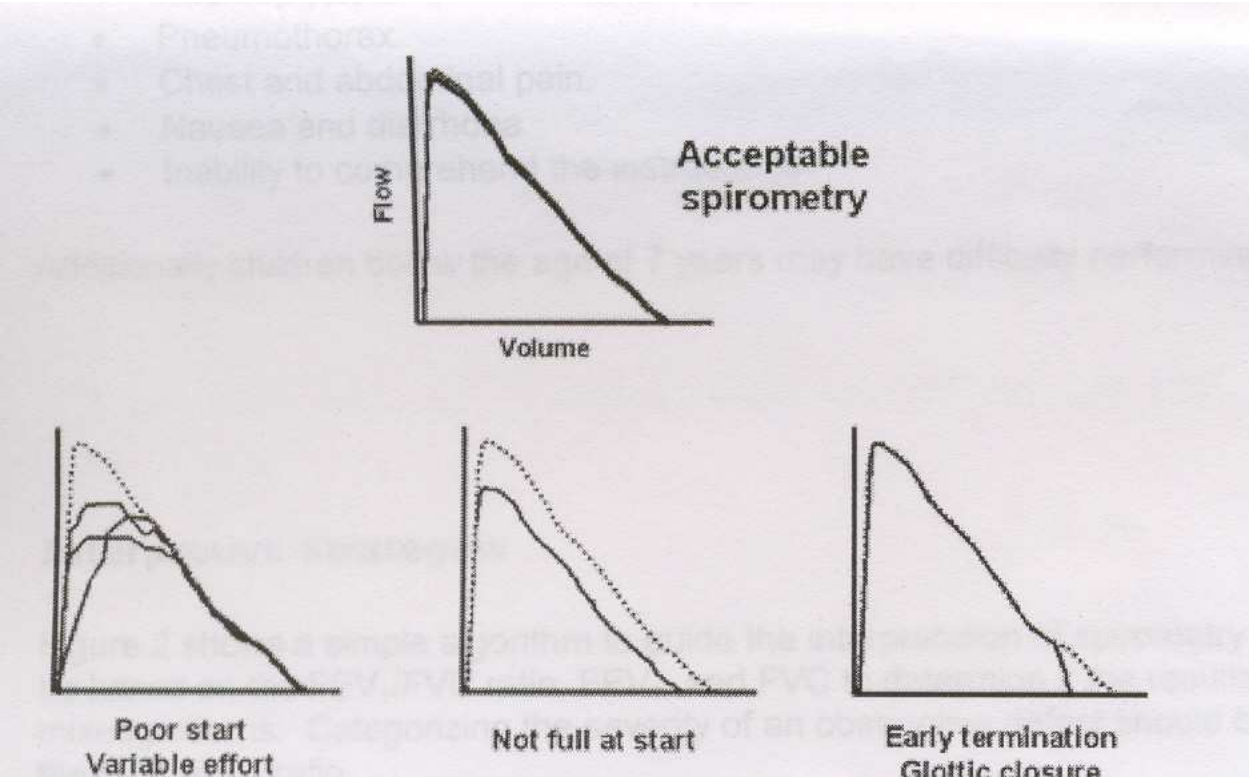

Flow
Volume
Acceptable spirometry
Poor start
Variable effort
Not full at start
Early termination

Figure 2

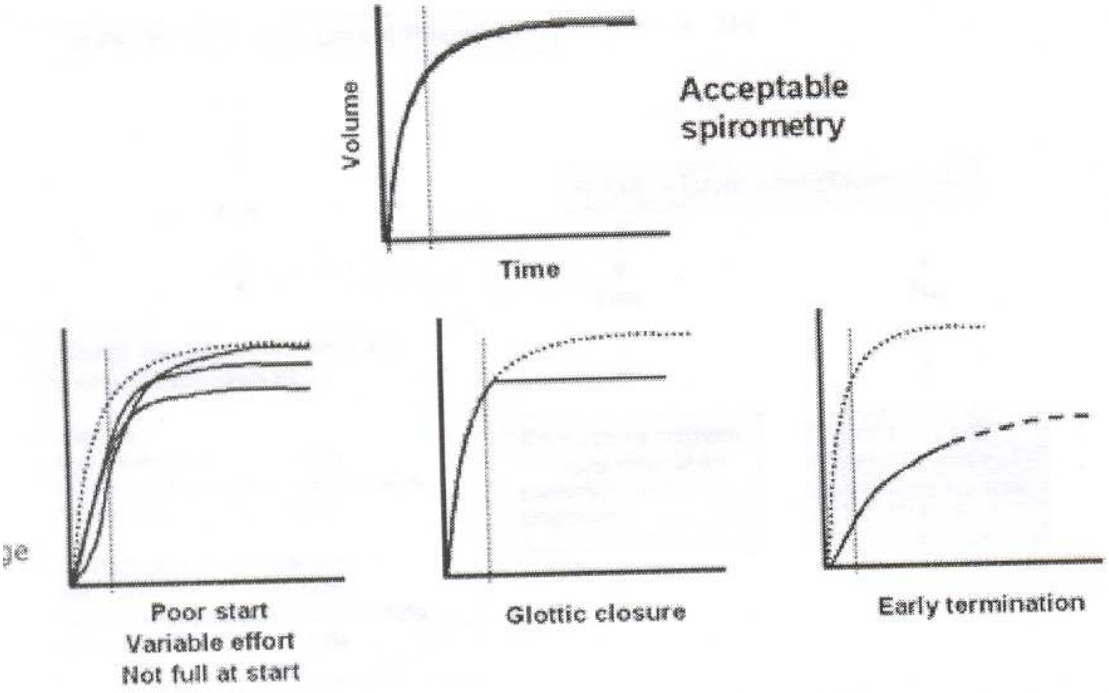

Volume
Time
Acceptable
spirometry
Poor start
Variable effort
Not full at start
Glottic closure
Early termination

Figure 3

Guideline for Spirometry Interpretation[27,28,29]

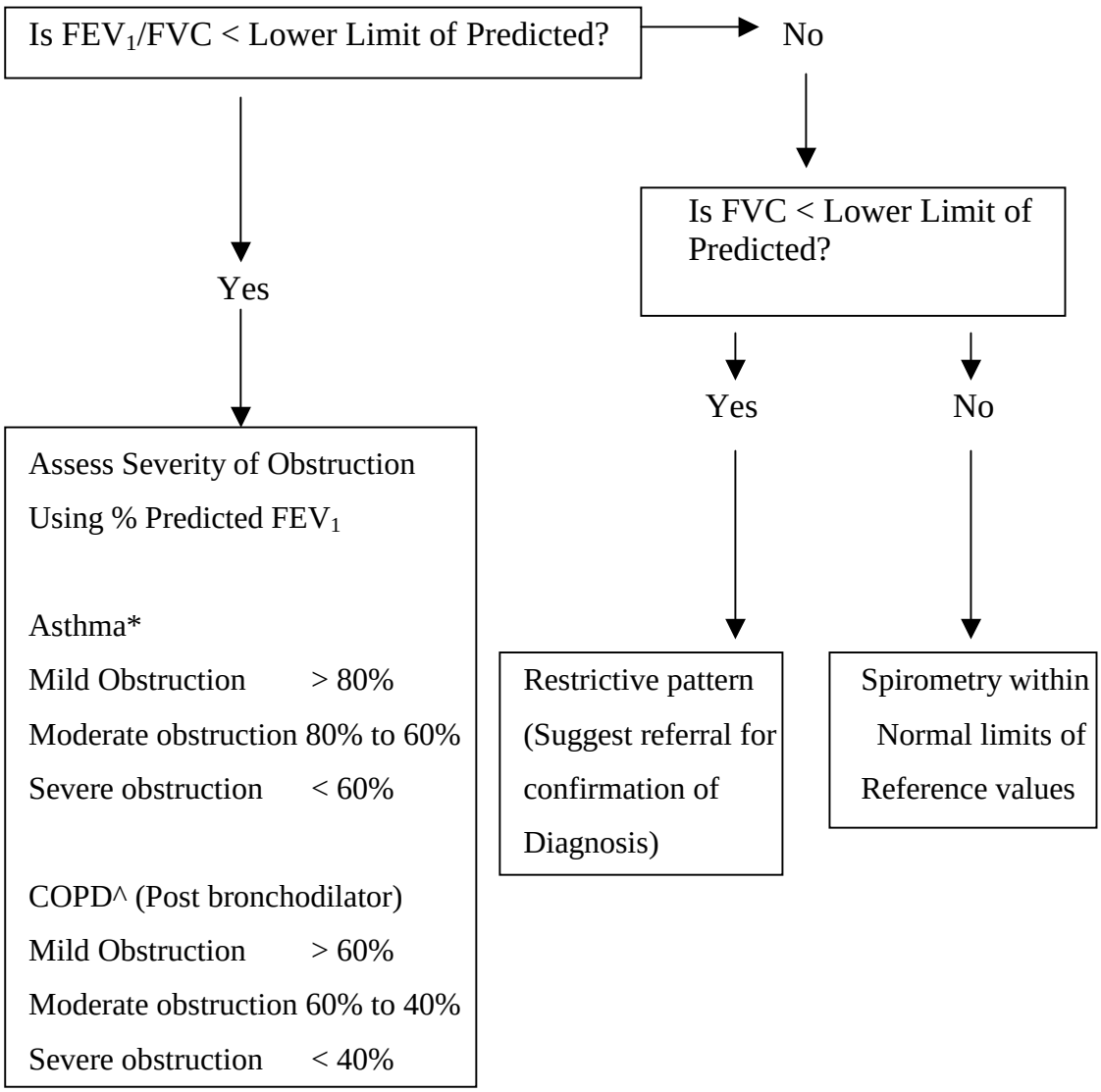


Figure 4

Generalised Classification of Ventilatory defects

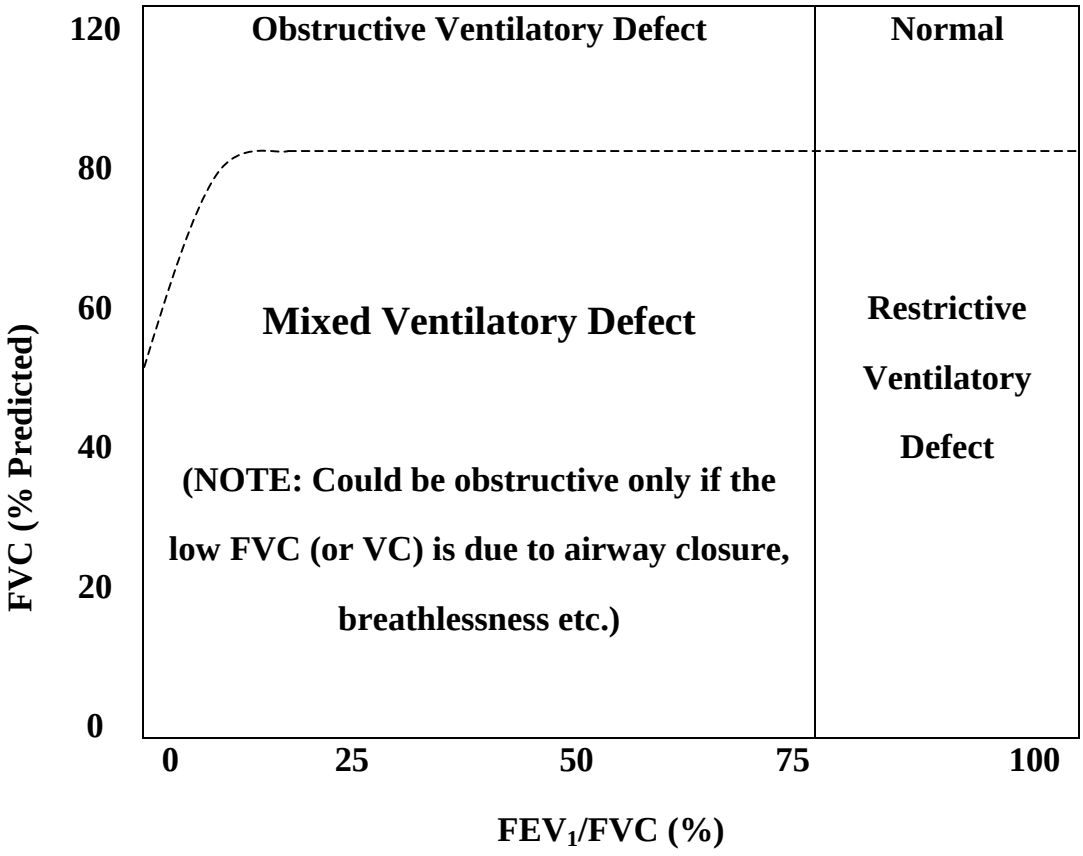


Figure 5

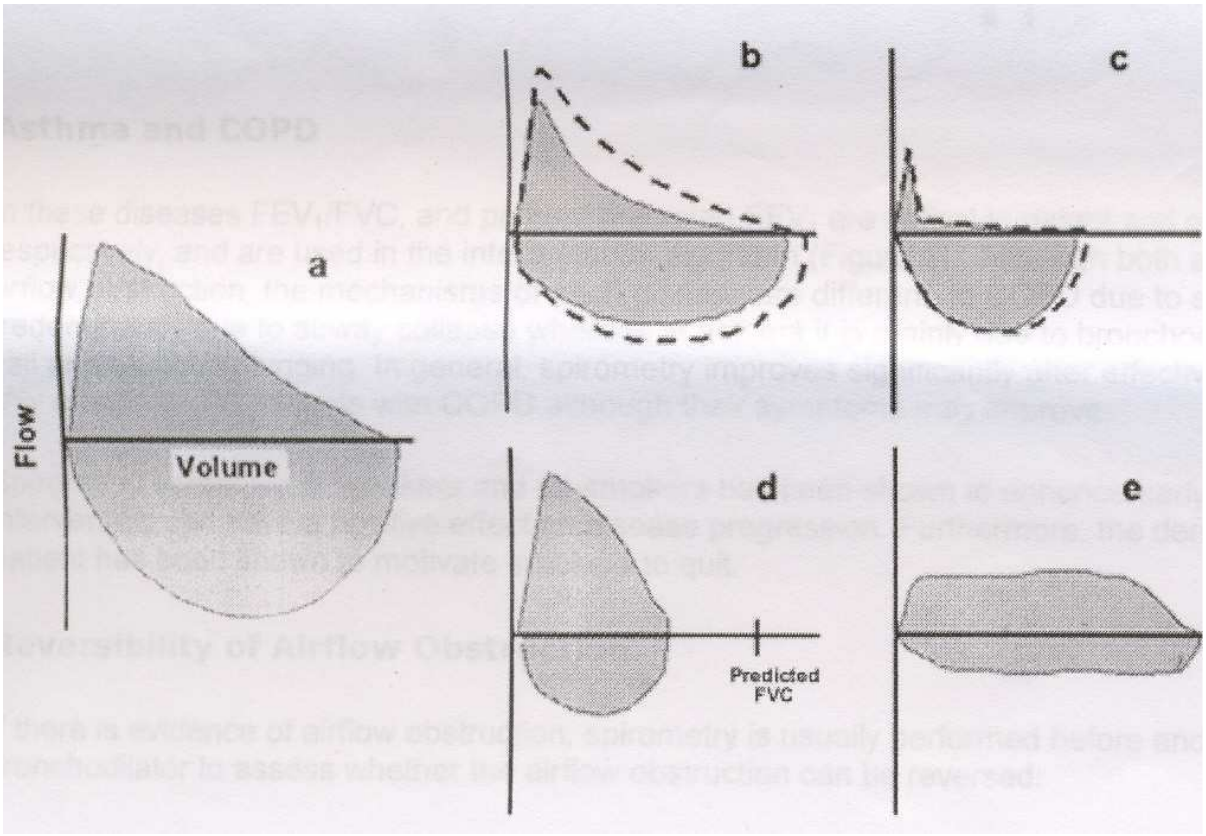
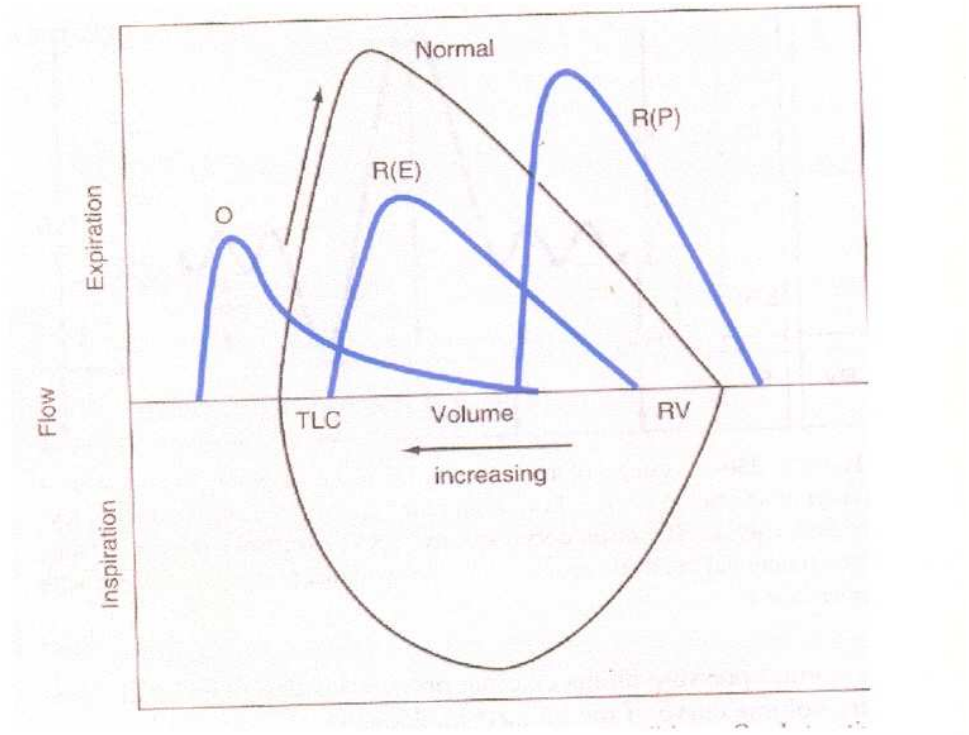


Figure 6



O - Obstructive Disease

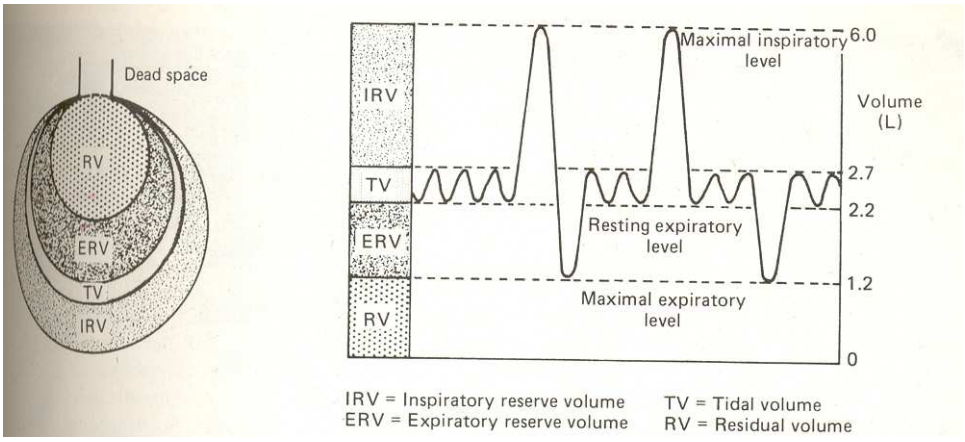
R (P) - Restrictive Parenchymal

R (E) - Restrictive Extraparenchymal

TLC - Total Lung Capacity

RV - Residual Volume

Figure 7



Volume (L)				
		Men	**Women**	
Vital Capacity	IRV	3.3	1.9	Inspiratory capacity
	TV	0.5	0.5	
	ERV	1.0	0.7	Functional Residual
	RV	1.2	1.1	capacity
Total Lung capacity		6.0	4.2	

Respiratory minute volume (rest) : 6 L/min

Alveolar ventilation (rest) : 4.2 L/min

Maximal voluntary ventilation (BTPS) : 125-170 L/min

Timed vital capacity : 83% of total in 1 s; 97% in 3 s

Work of quiet breathing : 0.5 kg-m/min

Maximal work of breathing : 10 kg-m / breath

MASTER CHART

Sl.No	NAME	AGE	Pack years	Cough	Chest pain	wheeze	Dys pnoea	Cre pitation	rhonchai	ECG	X-RAY	SPUTUM AFB	FEV1%	FVC%	$\frac{FEV_1}{FVC}$	$\frac{FEV_1}{FVC}$ %	FEF_{50}	FEF_{25-75}	TYPE
1	Ramasamy	35	13	No	-	-	-	-	-	Normal	Normal	Negative	83.5	99	0.84	84.34	83	83	Normal
2	Velayutham	47	18	No	-	-	-	-	-	Normal	Normal	Negative	85.6	110.5	0.77	77.47	81	90	Normal
3	Karuppathevar	53	44	Yes	-	-	-	-	-	Normal	Normal	Negative	86.8	113.7	0.76	76.34	87	89	Normal
4	Muthiah	51	60	No	-	-	-	-	-	Normal	Normal	Negative	80.9	120	0.67	67.42	70	71	Stage I
5	Venkatraman	52	18	No	-	-	-	-	-	Normal	Normal	Negative	89.1	109.9	0.81	81.07	87	86	Normal
6	Suresh	34	15	No	-	-	-	-	-	Normal	Normal	Negative	83.4	109	0.77	76.51	85	82	Normal
7	Chellam	44	40	Yes	-	-	-	-	-	Normal	Normal	Negative	84.1	109.6	0.77	76.73	85	84	Normal
8	Naguppillai	62	24	No	-	-	-	-	-	Normal	Normal	Negative	86.7	111	0.78	78.11	83	84	Normal
9	Raju	53	40	Yes	-	-	-	-	-	Normal	Normal	Negative	81.5	119.2	0.68	68.37	73	72	Stage I
10	Kundan	72	64	No	-	-	-	-	-	Normal	Normal	Negative	77	74.3	1.04	103.6	84	82	Restrictive
11	Rangasamy	51	28	No	-	-	-	-	-	Normal	Normal	Negative	89	106.4	0.84	83.65	80	84	Normal
12	Jeyaram	63	48	No	-	-	-	-	-	Normal	Normal	Negative	80.9	118.3	0.68	68.39	75	74	Stage I
13	Ramu	60	45	Yes	-	-	-	-	-	Normal	Normal	Negative	78.4	72.6	1.08	108	82	81	Restrictive
14	Muthukrishnan	42	16	No	-	-	-	-	-	Normal	Normal	Negative	83.7	99.9	0.84	83.78	88	85	Normal
15	Veeranan	47	40	Yes	-	-	-	-	-	Normal	Normal	Negative	80.5	118.6	0.68	67.88	71	70	Stage I
16	Govindan	51	48	No	-	-	-	-	-	Normal	Normal	Negative	84.8	105.5	0.8	80.38	87	85	Normal
17	Vailumuthu	39	18	No	-	-	-	-	-	Normal	Normal	Negative	85.6	108	0.79	79.26	86	81	Normal
18	Sudarsanam	45	28	Yes	-	-	-	-	-	Normal	Normal	Negative	81.7	118.8	0.69	68.77	73	73	Stage I
19	Ponniah	52	25	No	-	-	-	-	-	Normal	Normal	Negative	84.9	105.3	0.81	80.63	86	87	Normal
20	Periyagoundar	60	36	Yes	-	-	-	-	-	Normal	Normal	Negative	52.4	92.4	0.57	56.71	71	73	Stage II
21	Lakshmanan	58	28	No	-	-	-	-	-	Normal	Normal	Negative	84.8	106.6	0.8	79.55	83	80	Normal
22	Dharmar	45	40	Yes	-	-	-	-	-	Normal	Normal	Negative	84.9	109.4	0.78	77.61	83	87	Normal
23	Ramalingam	32	18	No	-	-	-	-	-	Normal	Normal	Negative	83	98	0.85	84.69	81	87	Normal
24	Subramani	49	30	No	-	-	-	-	-	Normal	Normal	Negative	80.2	119.2	0.67	67.28	73	74	Stage I
25	Vellaiyan	68	40	Yes	-	-	-	-	-	Normal	Normal	Negative	82.1	120	0.68	68.42	73	72	Stage I
26	Mani	68	32	No	-	-	-	-	-	Normal	Normal	Negative	85.2	107.8	0.79	79.04	82	84	Normal
27	Marisamy	56	36	No	-	-	-	-	-	Normal	Normal	Negative	81.9	119.4	0.69	68.59	75	74	Stage I
28	Nalluthevar	53	24	Yes	-	-	-	-	-	Normal	Normal	Negative	83.9	99.9	0.84	83.98	85	81	Normal

Sl.No	NAME	AGE	Pack years	Cough	Chest pain	wheeze	Dys pnoea	Cre pitation	rhonchai	ECG	X-RAY	SPUTUM AFB	FEV1%	FVC%	$\frac{FEV_1}{FVC}$	$\frac{FEV_1}{FVC}$ %	FEF_{50}	FEF_{25-75}	TYPE
29	Chinnian	45	18	No	-	-	-	-	-	Normal	Normal	Negative	85.4	111.3	0.77	76.73	81	81	Normal
30	Ranganathan	33	22	Yes	-	-	-	-	-	Normal	Normal	Negative	88.4	108	0.82	81.85	86	83	Normal
31	Krishnamoorthi	58	44	No	-	-	-	-	-	Normal	Normal	Negative	85.1	111.6	0.76	76.25	90	84	Normal
32	Varadhan	57	36	No	-	-	-	-	-	Normal	Normal	Negative	83.4	100.5	0.83	82.99	82	87	Normal
33	Abraham	59	64	No	-	-	-	-	-	Normal	Normal	Negative	76.3	70.5	1.08	108.2	84	88	Restrictive
34	Balusamy	62	44	Yes	-	-	-	-	-	Normal	Normal	Negative	85.9	109.6	0.78	78.38	83	80	Normal
35	Arockiasamy	52	40	Yes	-	-	-	-	-	Normal	Normal	Negative	85.3	110.5	0.77	77.19	90	85	Normal
36	Mujibur	58	21	No	-	-	-	-	-	Normal	Normal	Negative	84.8	106.6	0.8	79.55	83	80	Normal
37	Thomas	59	33	Yes	-	-	-	-	-	Normal	Normal	Negative	81.5	116.9	0.7	69.72	75	72	Stage I
38	Seeni	35	36	Yes	-	-	-	-	-	Normal	Normal	Negative	64.3	109.5	0.59	58.72	71	72	Stage II
39	Kuttiyappan	41	30	No	-	-	-	-	-	Normal	Normal	Negative	84.7	107.4	0.79	78.86	88	82	Normal
40	Abdullah	49	32	Yes	-	-	-	-	-	Normal	Normal	Negative	77.3	72.9	1.06	106	84	87	Restrictive
41	Micheal	52	30	No	-	-	-	-	-	Normal	Normal	Negative	83.6	101.5	0.82	82.36	88	83	Normal
42	Loganathan	57	50	No	-	-	-	-	-	Normal	Normal	Negative	75.9	73.4	1.03	103.4	88	87	Mixed
43	Kannuchamy	61	44	Yes	-	-	-	-	-	Normal	Normal	Negative	83.2	99.9	0.83	83.28	88	89	Normal
44	Joseph	55	45	No	-	-	-	-	-	Normal	Normal	Negative	80.7	116.2	0.69	69.45	74	75	Stage I
45	Kannuthevar	31	26	No	-	-	-	-	-	Normal	Normal	Negative	88.1	114.4	0.77	77.01	88	80	Normal
46	Subbunadar	36	30	No	-	-	-	-	-	Normal	Normal	Negative	86.5	115.3	0.75	75.02	82	85	Normal
47	Arulraj	43	16	No	-	-	-	-	-	Normal	Normal	Negative	86.3	112.7	0.77	76.57	84	87	Normal
48	Veeran	54	28	Yes	-	-	-	-	-	Normal	Normal	Negative	84.3	105.2	0.8	80.13	87	85	Normal
49	Lakshmanan	56	40	Yes	-	-	-	-	-	Normal	Normal	Negative	87.1	118.2	0.74	73.69	84	90	Normal
50	Usman	65	36	Yes	-	-	-	-	-	Normal	Normal	Negative	81.4	119.3	0.68	68.23	75	75	Stage I
51	Kasi Viswanathan	36	30	Yes	-	-	-	-	-	Normal	Normal	Negative	83.7	104.5	0.8	80.1	82	88	Normal
52	Logu	46	28	No	-	-	-	-	-	Normal	Normal	Negative	86.5	115.3	0.75	75.02	82	85	Normal
53	Kannan	41	36	No	-	-	-	-	-	Normal	Normal	Negative	89.4	113.4	0.79	78.84	86	87	Normal
54	Seenithevar	59	20	Yes	-	-	-	-	-	Normal	Normal	Negative	84.9	104.4	0.81	81.32	83	82	Normal
55	Palani	52	36	No	-	-	-	-	-	Normal	Normal	Negative	83.6	102.1	0.82	81.88	85	90	Normal
56	Singaram	62	48	No	-	-	-	-	-	Normal	Normal	Negative	84.7	109.4	0.77	77.42	88	87	Normal
57	Dennis	64	30	No	-	-	-	-	-	Normal	Normal	Negative	83.8	103.3	0.81	81.12	85	86	Normal
58	Arunachalam	54	15	Yes	-	-	-	-	-	Normal	Normal	Negative	83.7	101.1	0.83	82.79	90	84	Normal

Sl.No	NAME	AGE	Pack years	Cough	Chest pain	wheeze	Dys pnoea	Cre pitation	rhonchai	ECG	X-RAY	SPUTUM AFB	FEV1%	FVC%	$\frac{FEV_1}{FVC}$	$\frac{FEV_1}{FVC}$ %	FEF_{50}	FEF_{25-75}	TYPE
59	Vellaisamy	59	28	No	-	-	-	-	-	Normal	Normal	Negative	84.2	111	0.76	75.86	87	81	Normal
60	Peer Muhamed	65	32	No	-	-	-	-	-	Normal	Normal	Negative	89.9	113.2	0.79	79.42	83	81	Normal
61	Subburaj	62	18	No	-	-	-	-	-	Normal	Normal	Negative	88	105.5	0.83	83.41	87	90	Normal
62	Narayanan	41	32	No	-	-	-	-	-	Normal	Normal	Negative	85	111.8	0.76	76.03	87	86	Normal
63	Thiruppathi	47	20	Yes	-	-	-	-	-	Normal	Normal	Negative	83.7	100.6	0.83	83.2	86	90	Normal
64	Williams	34	22	No	-	-	-	-	-	Normal	Normal	Negative	86.7	109.9	0.79	78.89	88	81	Normal
65	Palavesam	47	20	No	-	-	-	-	-	Normal	Normal	Negative	83.7	100.6	0.83	83.2	86	90	Normal
66	Yousuf	55	32	No	-	-	-	-	-	Normal	Normal	Negative	85.5	109.3	0.78	78.23	88	83	Normal
67	Panneer	65	15	Yes	-	-	-	-	-	Normal	Normal	Negative	84.4	107.2	0.79	78.73	81	84	Normal
68	Nataraj	64	55	No	-	-	-	-	-	Normal	Normal	Negative	59	104	0.57	56.73	70	71	Stage II
69	Martin	32	16	No	-	-	-	-	-	Normal	Normal	Negative	84.1	105	0.8	80.1	87	86	Normal
70	Maruthu	44	12	Yes	-	-	-	-	-	Normal	Normal	Negative	89.2	112.8	0.79	79.08	83	90	Normal
71	Abbas	60	44	Yes	-	-	-	-	-	Normal	Normal	Negative	80.7	116.2	0.69	69.45	74	75	Stage I
72	Chinnamani	41	18	No	-	-	-	-	-	Normal	Normal	Negative	84.8	106.6	0.8	79.55	83	80	Normal
73	David	51	32	Yes	-	-	-	-	-	Normal	Normal	Negative	84.6	106	0.8	79.81	88	86	Normal
74	Anbarasan	35	12	No	-	-	-	-	-	Normal	Normal	Negative	87.6	115	0.76	76.17	80	82	Normal
75	Periyasamy	46	36	Yes	-	-	-	-	-	Normal	Normal	Negative	85.9	109.9	0.78	78.16	84	89	Normal
76	Natharshah	32	19	No	-	-	-	-	-	Normal	Normal	Negative	83.9	106	0.79	79.15	89	85	Normal
77	Maruthanayagam	42	15	No	-	-	-	-	-	Normal	Normal	Negative	85.6	110.3	0.78	77.61	82	82	Normal
78	Innasi	55	50	Yes	-	-	-	-	-	Normal	Normal	Negative	80.1	116.2	0.69	68.93	75	74	Stage I
79	Pasupathy	43	32	No	-	-	-	-	-	Normal	Normal	Negative	83.1	98.4	0.84	84.45	82	83	Normal
80	Rajkumar	58	36	No	-	-	-	-	-	Normal	Normal	Negative	87.7	116.4	0.75	75.34	89	80	Normal
81	Marthandam	54	32	Yes	-	-	-	-	-	Normal	Normal	Negative	85.9	105.3	0.82	81.58	85	82	Normal
82	Dharmalingam	45	22	No	-	-	-	-	-	Normal	Normal	Negative	84.3	106.7	0.79	79.01	86	84	Normal
83	Prakash	54	27	No	-	-	-	-	-	Normal	Normal	Negative	86	104.3	0.82	82.45	80	84	Normal
84	Nesamani	31	14	No	-	-	-	-	-	Normal	Normal	Negative	85.4	105	0.81	81.33	82	90	Normal
85	Chandran	55	26	No	-	-	-	-	-	Normal	Normal	Negative	85.2	110.6	0.77	77.03	81	83	Normal
86	Palavendran	58	60	Yes	-	-	-	-	-	Normal	Normal	Negative	78.9	74.2	1.06	106.3	85	86	Mixed
87	Sekaran	58	48	No	-	-	-	-	-	Normal	Normal	Negative	81.2	118.9	0.68	68.29	72	71	Stage I
88	Natarajan	62	20	No	-	-	-	-	-	Normal	Normal	Negative	83.9	102.5	0.82	81.85	85	86	Normal

Sl.No	NAME	AGE	Pack years	Cough	Chest pain	wheeze	Dys pnoea	Cre pitation	rhonchai	ECG	X-RAY	SPUTUM AFB	FEV1%	FVC%	$\frac{FEV_1}{FVC}$	$\frac{FEV_1}{FVC}$ %	FEF_{50}	FEF_{25-75}	TYPE
89	Issac	43	12	No	-	-	-	-	-	Normal	Normal	Negative	83.9	99.3	0.84	84.49	88	81	Normal
90	Thanasekaran	52	30	Yes	-	-	-	-	-	Normal	Normal	Negative	84.5	106.9	0.79	79.05	80	88	Normal
91	Annamalai	59	52	No	-	-	-	-	-	Normal	Normal	Negative	87.7	116.6	0.75	75.21	89	82	Normal
92	Saravanan	39	14	No	-	-	-	-	-	Normal	Normal	Negative	87.6	111	0.79	78.92	85	81	Normal
93	Rajagopalan	42	32	Yes	-	-	-	-	-	Normal	Normal	Negative	81.6	118.4	0.69	68.92	75	74	Stage I
94	Namasivayam	57	39	No	-	-	-	-	-	Normal	Normal	Negative	82.4	118.2	0.7	69.71	71	73	Stage I
95	Ibrahim	34	22	Yes	-	-	-	-	-	Normal	Normal	Negative	82.9	117.3	0.71	70.67	73	74	Stage I
96	Kamarajan	64	21	Yes	-	-	-	-	-	Normal	Normal	Negative	80.5	117.4	0.69	68.57	72	74	Stage I
97	Thandapani	41	24	No	-	-	-	-	-	Normal	Normal	Negative	86.2	114.2	0.75	75.48	85	84	Normal
98	Pakker Mohamed	57	48	No	-	-	-	-	-	Normal	Normal	Negative	81.3	120	0.68	67.75	73	74	Stage I
99	Dhanapal	35	15	No	-	-	-	-	-	Normal	Normal	Negative	84.7	112	0.76	75.63	90	82	Normal
100	Amalraj	59	44	Yes	-	-	-	-	-	Normal	Normal	Negative	82.4	118.2	0.7	69.71	71	73	Stage I
101	Mahalingam	41	32	No	-	-	-	-	-	Normal	Normal	Negative	85	111.8	0.76	76.03	87	86	Normal
102	Sundarraj	59	44	No	-	-	-	-	-	Normal	Normal	Negative	66.6	110.1	0.6	60.49	72	71	Stage II
103	Fulgunan	47	28	No	-	-	-	-	-	Normal	Normal	Negative	87.5	107.5	0.81	81.4	84	83	Normal
104	Rajendraprasad	38	22	No	-	-	-	-	-	Normal	Normal	Negative	86.2	103	0.84	83.69	83	85	Normal
105	Senthilkumar	53	48	No	-	-	-	-	-	Normal	Normal	Negative	88	114.3	0.77	76.99	82	90	Normal
106	Rahamadulla	50	40	No	-	-	-	-	-	Normal	Normal	Negative	81.5	116.9	0.7	69.72	75	72	Stage I
107	Chakravarthi	59	60	No	-	-	-	-	-	Normal	Normal	Negative	80.6	118.4	0.68	68.07	74	75	Stage I
108	Nazirudin	46	12	No	-	-	-	-	-	Normal	Normal	Negative	84.7	102.4	0.83	82.71	83	81	Normal
109	Govindaraj	33	25	Yes	-	-	-	-	-	Normal	Normal	Negative	82.2	113.9	0.72	72.17	75	73	Stage I
110	Sarathy	64	55	No	-	-	-	-	-	Normal	Normal	Negative	80.2	116.2	0.69	69.02	74	73	Stage I
111	Nizam Ali	60	20	No	-	-	-	-	-	Normal	Normal	Negative	83.1	98.4	0.84	84.45	88	80	Normal
112	Seeni Rowthar	37	11	No	-	-	-	-	-	Normal	Normal	Negative	83.9	99	0.85	84.75	90	86	Normal
113	Arockiaraj	48	11	No	-	-	-	-	-	Normal	Normal	Negative	83.2	100.1	0.83	83.12	87	88	Normal
114	Jeyapaul	62	36	No	-	-	-	-	-	Normal	Normal	Negative	81.7	119.4	0.68	68.43	74	75	Stage I
115	Sethuraman	42	28	No	-	-	-	-	-	Normal	Normal	Negative	88.3	104.7	0.84	84.34	85	89	Normal
116	Bhaskaran	65	36	No	-	-	-	-	-	Normal	Normal	Negative	83.4	100.5	0.83	82.99	82	87	Normal
117	Karuppanan	32	16	Yes	-	-	-	-	-	Normal	Normal	Negative	84.1	106	0.79	79.34	80	87	Normal
118	Santhakumar	63	24	No	-	-	-	-	-	Normal	Normal	Negative	84.2	108.6	0.78	77.53	81	80	Normal

Sl.No	NAME	AGE	Pack years	Cough	Chest pain	wheeze	Dys pnoea	Cre pitation	rhonchai	ECG	X-RAY	SPUTUM AFB	FEV1%	FVC%	$\frac{FEV_1}{FVC}$	$\frac{FEV_1}{FVC}$ %	FEF_{50}	FEF_{25-75}	TYPE
119	Loganathan	65	25	No	-	-	-	-	-	Normal	Normal	Negative	84.6	104	0.81	81.35	84	83	Normal
120	Rahimbai	42	24	No	-	-	-	-	-	Normal	Normal	Negative	80.3	119	0.67	67.48	74	75	Stage I
121	Muniandi	39	24	No	-	-	-	-	-	Normal	Normal	Negative	85.7	101	0.85	84.85	84	86	Normal
122	Jhonson	64	29	No	-	-	-	-	-	Normal	Normal	Negative	84.1	107.5	0.78	78.23	82	80	Normal
123	Parthasarathy	62	40	Yes	-	-	-	-	-	Normal	Normal	Negative	87.6	112.8	0.78	77.66	86	88	Normal
124	Gurusamy	51	64	No	-	-	-	-	-	Normal	Normal	Negative	86.3	112.7	0.77	76.57	84	87	Normal
125	Chinnamani	61	60	No	-	-	-	-	-	Normal	Normal	Negative	67	108.3	0.62	61.87	71	73	Stage II
126	Soundararajan	31	16	No	-	-	-	-	-	Normal	Normal	Negative	84.6	108	0.78	78.33	80	86	Normal
127	Balaji	33	12	No	-	-	-	-	-	Normal	Normal	Negative	85.2	103	0.83	82.72	81	83	Normal
128	Muraldharan	48	36	Yes	-	-	-	-	-	Normal	Normal	Negative	55.7	96.4	0.58	57.78	71	72	Stage II
129	Panneerselvam	54	28	No	-	-	-	-	-	Normal	Normal	Negative	86.4	115.2	0.75	75	81	87	Normal
130	Nagaraja	31	16	No	-	-	-	-	-	Normal	Normal	Negative	89.6	118.2	0.76	75.8	85	87	Normal
131	Jegadeesan	58	30	No	-	-	-	-	-	Normal	Normal	Negative	87.6	116.6	0.75	75.13	80	80	Normal
132	Pandiaraj	53	24	Yes	-	-	-	-	-	Normal	Normal	Negative	85.6	114	0.75	75.09	81	86	Normal
133	Rajappan	64	28	No	-	-	-	-	-	Normal	Normal	Negative	80.7	118	0.68	68.39	75	74	Stage I
134	Kunjappan	51	24	No	-	-	-	-	-	Normal	Normal	Negative	85.4	100.8	0.85	84.72	85	88	Normal
135	Vadivel	57	30	No	-	-	-	-	-	Normal	Normal	Negative	88.1	114.4	0.77	77.01	88	80	Normal
136	Jacob	65	50	No	-	-	-	-	-	Normal	Normal	Negative	79	72.4	1.09	109.1	89	91	Mixed
137	Balu	55	24	No	-	-	-	-	-	Normal	Normal	Negative	88.2	114.3	0.77	77.17	83	89	Normal
138	Ravindran	61	21	No	-	-	-	-	-	Normal	Normal	Negative	83.4	104.9	0.8	79.5	86	85	Normal
139	Sangu Goundar	37	12	Yes	-	-	-	-	-	Normal	Normal	Negative	84.9	111	0.76	76.49	85	81	Stage I
140	Thanikachalam	63	28	No	-	-	-	-	-	Normal	Normal	Negative	86.7	114	0.76	76.05	86	89	Normal
141	Cherian	59	33	No	-	-	-	-	-	Normal	Normal	Negative	53.5	94.8	0.56	56.43	73	72	Stage II
142	Anandan	31	24	No	-	-	-	-	-	Normal	Normal	Negative	85.4	117	0.73	72.99	84	90	Normal
143	Veerabahu	64	42	No	-	-	-	-	-	Normal	Normal	Negative	87.4	112	0.78	78.04	87	88	Normal
144	Duraisamy	52	30	No	-	-	-	-	-	Normal	Normal	Negative	84.7	109.4	0.77	77.42	80	82	Normal
145	Rajangam	40	18	Yes	-	-	-	-	-	Normal	Normal	Negative	83	109	0.76	76.15	84	85	Normal
146	Sudalaiandi	65	48	Yes	-	-	-	-	-	Normal	Normal	Negative	81.1	119.5	0.68	67.87	73	72	Stage I
147	Thiagarajan	48	30	No	-	-	-	-	-	Normal	Normal	Negative	80.1	119.7	0.67	66.92	74	73	Stage I
148	Vincent	65	33	No	-	-	-	-	-	Normal	Normal	Negative	85.6	110.3	0.78	77.61	82	82	Normal

Sl.No	NAME	AGE	Pack years	Cough	Chest pain	wheeze	Dys pnoea	Cre pitation	rhonchai	ECG	X-RAY	SPUTUM AFB	FEV1%	FVC%	$\frac{FEV_1}{FVC}$	$\frac{FEV_1}{FVC}$ %	FEF_{50}	FEF_{25-75}	TYPE
149	Kumaraguru	58	20	Yes	-	-	-	-	-	Normal	Normal	Negative	86.4	110	0.79	78.55	81	87	Normal
150	Bangaru	32	20	No	-	-	-	-	-	Normal	Normal	Negative	85.1	106	0.8	80.28	86	83	Normal
151	Rajendran	45	Nil	No	-	-	-	-	-	Normal	Normal	Negative	84.2	115.2	0.84	84.34	83	83	Normal
152	Vellaisamy	38	Nil	No	-	-	-	-	-	Normal	Normal	Negative	85.6	110.5	0.77	77.47	81	90	Normal
153	Subburajan	72	Nil	No	-	-	-	-	-	Normal	Normal	Negative	86.8	113.7	0.76	76.34	87	89	Normal
154	Mookkandi	57	Nil	No	-	-	-	-	-	Normal	Normal	Negative	80.9	120	0.67	67.42	70	71	Normal
155	Nallusamy	64	Nil	Yes	-	-	-	-	-	Normal	Normal	Negative	89.1	109.9	0.81	81.07	87	86	Normal
156	James	70	Nil	No	-	-	-	-	-	Normal	Normal	Negative	83.4	109	0.77	76.51	85	82	Normal
157	Fakrudheen	43	Nil	No	-	-	-	-	-	Normal	Normal	Negative	84.1	109.6	0.77	76.73	85	84	Normal
158	Palavesakonar	39	Nil	No	-	-	-	-	-	Normal	Normal	Negative	86.7	111	0.78	78.11	83	84	Normal
159	Babulal	54	Nil	No	-	-	-	-	-	Normal	Normal	Negative	81.5	119.2	0.68	68.37	73	72	Normal
160	Rangegoundar	67	Nil	No	-	-	-	-	-	Normal	Normal	Negative	77	74.3	1.04	103.63	84	82	Normal
161	Arockiam	59	Nil	No	-	-	-	-	-	Normal	Normal	Negative	89	106.4	0.84	83.65	80	84	Normal
162	Thangadurai	48	Nil	No	-	-	-	-	-	Normal	Normal	Negative	80.9	118.3	0.68	68.39	75	74	Normal
163	Sridharan	64	Nil	No	-	-	-	-	-	Normal	Normal	Negative	78.4	72.6	1.08	107.99	82	81	Normal
164	Rangannan	71	Nil	No	-	-	-	-	-	Normal	Normal	Negative	83.7	99.9	0.84	83.78	88	85	Normal
165	Krishnan	52	Nil	No	-	-	-	-	-	Normal	Normal	Negative	80.5	118.6	0.68	67.88	71	70	Normal
166	Rajarathinam	61	Nil	No	-	-	-	-	-	Normal	Normal	Negative	84.8	105.5	0.80	80.38	87	85	Normal
167	Chokkanathan	48	Nil	Yes	-	-	-	-	-	Normal	Normal	Negative	85.6	108	0.79	79.2	86	81	Normal

Sl.No	NAME	AGE	Pack years	Cough	Chest pain	wheeze	Dys pnoea	Cre pitation	rhonchai	ECG	X-RAY	SPUTUM AFB	FEV1%	FVC%	$\frac{FEV_1}{FVC}$	$\frac{FEV_1}{FVC}$ %	FEF_{50}	FEF_{25-75}	TYPE
																6			
168	Williams	57	Nil	No	-	-	-	-	-	Normal	Normal	Negative	81.7	118.8	0.69	68.77	73	73	Normal
169	Dhandapani	60	Nil	No	-	-	-	-	-	Normal	Normal	Negative	84.9	105.3	0.81	80.63	86	87	Normal
170	Karuppan	45	Nil	No	-	-	-	-	-	Normal	Normal	Negative	52.4	92.4	0.57	56.71	71	73	Normal
171	Robert	74	Nil	No	-	-	-	-	-	Normal	Normal	Negative	84.8	106.6	0.80	79.55	83	80	Normal
172	Ismail	47	Nil	No	-	-	-	-	-	Normal	Normal	Negative	84.9	109.4	0.78	77.61	83	87	Stage I
173	Raju	72	Nil	Yes	-	-	-	-	-	Normal	Normal	Negative	83	98	0.85	84.69	81	87	Normal
174	Malleswaran	53	Nil	No	-	-	-	-	-	Normal	Normal	Negative	80.2	119.2	0.67	67.28	73	74	Normal
175	Surianarayanan	68	Nil	No	-	-	-	-	-	Normal	Normal	Negative	82.1	120	0.68	68.42	73	72	Normal
176	Venkatraj	52	Nil	Yes	-	-	-	-	-	Normal	Normal	Negative	85.2	107.8	0.79	79.04	82	84	Normal
177	Manickam	48	Nil	No	-	-	-	-	-	Normal	Normal	Negative	81.9	119.4	0.69	68.59	75	74	Normal
178	Prakasam	56	Nil	No	-	-	-	-	-	Normal	Normal	Negative	83.9	99.9	0.84	83.98	85	81	Normal
179	Thirumal	60	Nil	No	-	-	-	-	-	Normal	Normal	Negative	85.4	111.3	0.77	76.73	81	81	Normal
180	Subbanna	55	Nil	No	-	-	-	-	-	Normal	Normal	Negative	88.4	108	0.82	81.85	86	83	Normal
181	Babuji	42	Nil	No	-	-	-	-	-	Normal	Normal	Negative	85.1	111.6	0.76	76.25	90	84	Normal
182	Velu	37	Nil	No	-	-	-	-	-	Normal	Normal	Negative	83.4	100.5	0.83	82.99	82	87	Normal
183	Duraiappan	42	Nil	No	-	-	-	-	-	Normal	Normal	Negative	76.3	70.5	1.08	108.23	84	88	Normal
184	Jeevanandham	35	Nil	No	-	-	-	-	-	Normal	Normal	Negative	85.9	109.6	0.78	78.38	83	80	Normal

Sl.No	NAME	AGE	Pack years	Cough	Chest pain	wheeze	Dys pnoea	Cre pitation	rhonchai	ECG	X-RAY	SPUTUM AFB	FEV1%	FVC%	$\frac{FEV_1}{FVC}$	$\frac{FEV_1}{FVC}$ %	FEF_{50}	FEF_{25-75}	TYPE
185	Madhavan	59	Nil	No	-	-	-	-	-	Normal	Normal	Negative	85.3	110.5	0.77	77.19	90	85	Normal
186	Chandrasekaran	69	Nil	No	-	-	-	-	-	Normal	Normal	Negative	84.8	106.6	0.80	79.55	83	80	Normal
187	Varadarajan	67	Nil	No	-	-	-	-	-	Normal	Normal	Negative	81.5	116.9	0.70	69.72	75	72	Normal
188	Joel	42	Nil	No	-	-	-	-	-	Normal	Normal	Negative	64.3	109.5	0.59	58.72	71	72	Normal
189	Mohemmad	38	Nil	No	-	-	-	-	-	Normal	Normal	Negative	84.7	107.4	0.79	78.86	88	82	Normal
190	Punniakodi	51	Nil	No	-	-	-	-	-	Normal	Normal	Negative	77.3	72.9	1.06	106.04	84	87	Normal
191	Sitaraman	46	Nil	No	-	-	-	-	-	Normal	Normal	Negative	83.6	101.5	0.82	82.36	88	83	Normal
192	Ilango	62	Nil	No	-	-	-	-	-	Normal	Normal	Negative	75.9	73.4	1.03	103.41	88	87	Normal
193	Dharmarajan	39	Nil	No	-	-	-	-	-	Normal	Normal	Negative	83.2	99.9	0.83	83.28	88	89	Normal
194	Packianathan	44	Nil	No	-	-	-	-	-	Normal	Normal	Negative	80.7	116.2	0.69	69.45	74	75	Normal
195	Arunagiri	57	Nil	No	-	-	-	-	-	Normal	Normal	Negative	88.1	114.4	0.77	77.01	88	80	Normal
196	Paranjothy	53	Nil	No	-	-	-	-	-	Normal	Normal	Negative	86.5	115.3	0.75	75.02	82	85	Normal
197	Innasi Goundar	48	Nil	Yes	-	-	-	-	-	Normal	Normal	Negative	86.3	112.7	0.77	76.57	84	87	Normal
198	Deenadayalan	37	Nil	No	-	-	-	-	-	Normal	Normal	Negative	84.3	105.2	0.80	80.13	87	85	Normal
199	Venkoban	54	Nil	No	-	-	-	-	-	Normal	Normal	Negative	87.1	118.2	0.74	73.69	84	90	Normal
200	Francis	61	Nil	No	-	-	-	-	-	Normal	Normal	Negative	81.4	119.3	0.68	68.23	75	75	Normal